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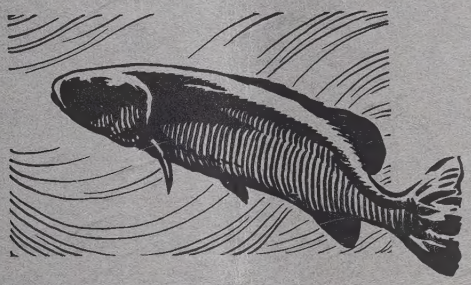

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary

FISH AND WILDLIFE SERVICE
Albert M. Day, Director

The Progressive Fish-Culturist

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A Quarterly for Fishery Biologists and Fish-Culturists

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LABOR TO PRODUCE FIFTY TONS OF TROUT: A TIME STUDY

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Rome, New York

ONE OF THE MAJOR COSTS of trout culture is for labor. Kingsbury (1951) presented a cost analysis of one New York State Hatchery in which personal service represented 44.1 percent of the total cost; maintenance and operation, 12.7 percent; and fish food, 43.2 percent. In the hatchery used for the present study, corresponding figures for the last fiscal year were personal service, 43.9 percent; maintenance and operation, 11.3 percent; and fish food, 44.8 percent. These percentages do not include depreciation and interest on the capital investment.

Economies in fish food have been given careful and widespread attention during the past decade. Labor costs have, in general, been considered much less carefully.

PURPOSE

The time study herein reported was made to explore the possibilities of reducing and rearranging labor utilization in order to provide more time for (1) plant maintenance during extremely busy periods; (2) care of grounds, particularly in the spring, which is one of the busiest periods; (3) care of fingerlings during the first months of feeding; and (4) experimentation.

BACKGROUND

The Rome Hatchery is a trout-producing unit with an annual production which, within the past 5 years, has increased from about 60,000 to 100,000 pounds per year. During this period the number of employees has been increased from 12 to 14. Thus production has increased about 67 percent and labor 17 percent. It has become increasingly evident to management that the building and ground maintenance has suffered. It was felt that a study of labor utilization might indicate economies which would permit adequate fish culture and maintenance without additional expenditures.

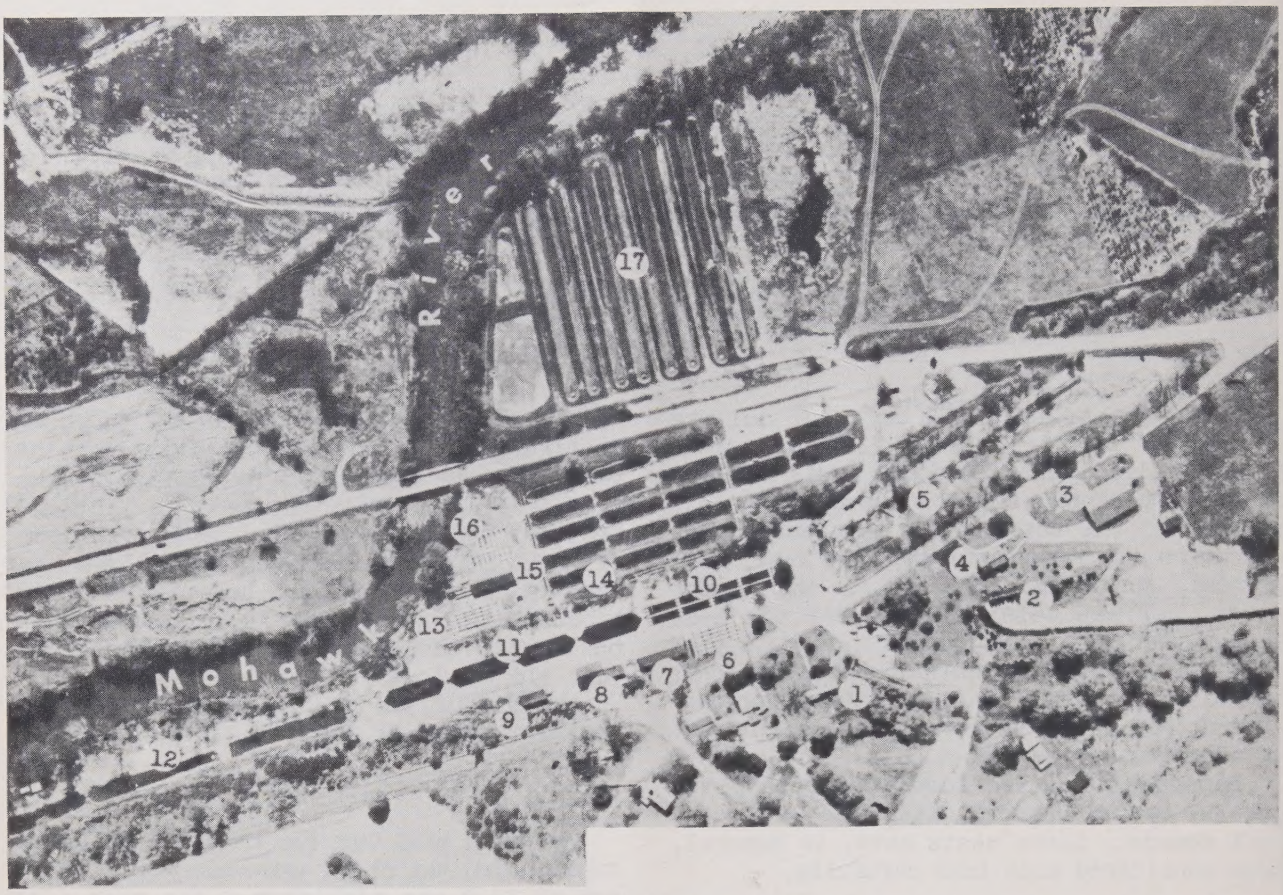
The plan of the Rome Hatchery is shown in figure 1. The trout facilities consist of 48 hatching troughs and 136 rearing troughs with a combined water volume of 1,480 cubic feet; 37 rearing ponds with a water volume of about 125,000 cubic feet; and 10 quarter-acre mud ponds which have been used for the production of muskellunge, bass, and minnows but are now used for the production of 2-year-old trout.

The production of the hatchery for the period of study is shown in table 1.

TIME STUDY

The total paid time for the year (excluding supervision) was 37,162 man-hours, or an average of 14.8 men working a 6-day week. As 100,000 pounds of fish were produced during the year, a total of 0.37 man-hour of labor was used per pound. With a labor cost of $1 an hour (the actual cost for the period of the study), division of the total number of man-hours by 1,000 gives a cost per pound for labor of 37 cents. (Similarly, throughout the paper, man-hours divided by 1,000 will give cents per pound of total production.) The division of the labor into six major headings is shown in table 2. Each of the items of table 2 will be broken down into its components later. For the moment it suffices to say that "Fish-cultural activities" covers all effort in rearing the fish, including preparation of the feed. "Shipping" includes delivery time and planting time, as well as time spent loading at the hatchery. "General maintenance" includes maintenance of grounds, buildings, trucks, and other equipment. The term "Miscellaneous" includes such unclassified items as the time of a man temporarily loaned to another hatchery. "Time off" includes a 24-day annual vacation for every employee with 1 year's service, sick leave, and jury duty.

Figure 2 shows the monthly variation in the six major items. In the graph, "Time off"



(Photograph by New York State Conservation Department)

FIGURE 1.--Fish hatchery at Rome, New York. Key: 1--Main spring. 2--"Creek" spring. 3--Garage. 4--Foreman's residence. 5--Three south ponds (lake water). 6--South troughs (72 rearing troughs). 7--Hatchery. 8--Cold-storage plant. 9--Garage. 10--Upper eight spring-water ponds. 11--Lower four spring-water ponds. 12--Three north ponds (lake water). 13--East troughs (60 rearing troughs). 14--Nineteen east ponds (mixture of spring and lake water). 15--Laboratory. 16--Laboratory experimental ponds. 17--Ten flat ponds (lake water).

is represented by the space between the top of the bar for the month and the solid line for "Hours paid." In 3 months (February, March, and April), it was necessary to work overtime; so the number of hours worked in each month exceeded the "Hours paid." This accumulated overtime is credited as vacation for the employee and is taken in subsequent months in addition to the regular vacation.

It will be noted that "Fish culture" increases abruptly in December, when the fry start feeding, and continues high until June, with a maximum in January. "Shipping" is large from February through June, with a peak in March. A brief but intensive shipping period occurs in September. The combination of "Fish culture" and "Shipping" highs from February to June constitutes one of the major problems of the hatchery. The picture of the year of the study is not quite typical in this respect, as labor funds were made available during January, February, and March for temporary help, averaging 2.5 men for these 3 months, or approximately 600 man-hours per month. This added labor made possible the maintenance items in January and February and permitted a high shipping effort in March, which in turn reduced the pressure in April, May, and June.

In a "normal" year maintenance is negligible from January to June, except for essential truck repairs and a minimum effort to keep lawns at something less than hay. The search for time to do the maintenance as the need occurs, constitutes one of the reasons for this study.

In figure 3 the major headings already discussed are subdivided. Hatchery activities

TABLE 1.--Production summary, July 1, 1950 to June 30, 1951

Species	Shipped out		Shipped in		Length (inches)
	Number	Weight	Number	Weight	
Brook trout	0	0	570,249	69.10	eyed eggs
Brook trout	355,931	672.50	250,000	202.20	1 - 1.75
Brook trout	373,945	2,782.11	88,575	1,456.10	2 - 3.75
Brook trout	155,428	10,298.00	155,095	10,308.60	4 - 6.75
Brook trout	7,039	1,105.00	6,739	1,053.00	7 plus
Brown trout	0	0	2,146,256	431.00	eyed eggs
Brown trout	100,241	110.50	100,000	90.50	1 - 1.75
Brown trout	371,630	1,856.90	103,150	878.00	2 - 3.75
Brown trout	708,464	67,733.90	0	0	4 - 6.75
Brown trout	42,202	13,975.60	2,000	328.00	7 plus
Rainbow trout	0	0	372,380	76.40	eyed eggs
Rainbow trout	37,150	49.10	40,000	39.75	1 - 1.75
Rainbow trout	171,758	1,103.00	0	0	2 - 3.75
Rainbow trout	84,106	5,124.68	0	0	4 - 6.75
Rainbow trout	45,091	9,229.50	105	45.60	7 plus

Shipping credit		99,062.54
Inventory, July 1, 1950	20,301.0	
Inventory, June 30, 1951	21,418.6	
Inventory credit		1,117.60
Pounds produced		100,180.14

were divided into 58 items, and an individual record was kept of the time spent on each. Throughout the study, owing to oversights in bookkeeping, an "Unaccounted for" item amounting to 2 percent of the total appears each month. This time represents failure to record all of the activity for the day.

The detailed inspection of figure 3 will be left to the reader. It is evident that if the stated purposes of the study are to be accomplished, economies will be necessary in the large items. Items under "Fish culture" and "Shipping" that exceed 500 man-hours per year have been segregated for study. These are:

1. Ponds	
a. Feeding	2,177½
b. Cleaning screens	2,100
c. Transfers including sorting	1,517½
2. Nightwatch	4,756
3. Shipments	
a. Yearling and 2-year trucking	2,188
b. Fingerling trucking	970
c. Yearling and 2-year loading	996½
4. Troughs	
a. Feeding and cleaning	2,831
5. Food preparation	2,950
6. Sunday work	1,308
Total	21,794½

These items represent 65 percent of the total effort spent during the year, excluding vacations which are fixed by regulation. Each of these items will be examined for possible savings.

1-a. Pond Feeding

Since feeding the fish is obviously one of the most important functions in hatchery success, no direct saving in time spent in proper feeding is desirable. The methods used to weigh and transport the feed are, however, inefficient. It has been the practice to weigh about a dozen pails of feed in the meat room, put the load on a truck, drive with three men to the ponds, give the feed to the fish, and return for another load, the process being repeated until all the ponds are fed. The system has recently been changed. The man who prepares the feed dumps it on a pick-up truck as he prepares it. When preparation is complete, the three feeders put a set of scales on the truck and drive to the ponds, weigh the feed, and feed the ponds, progressing around the pond system until they are finished. It is estimated that 25 percent of the "feeding" time is saved.

TABLE 2.--Total man-hours of labor for the year

	Man-hours	Man-years	Percent of total
Fish-cultural activities	21,582½	8.6	58.1
Shipping	4,450	1.8	12.0
General Maintenance	4,797	1.9	12.9
Clerical	905½	.4	2.4
Miscellaneous	1,797½	.7	4.8
Time off	3,629½	1.4	9.8
Total	37,162	14.8	100.0

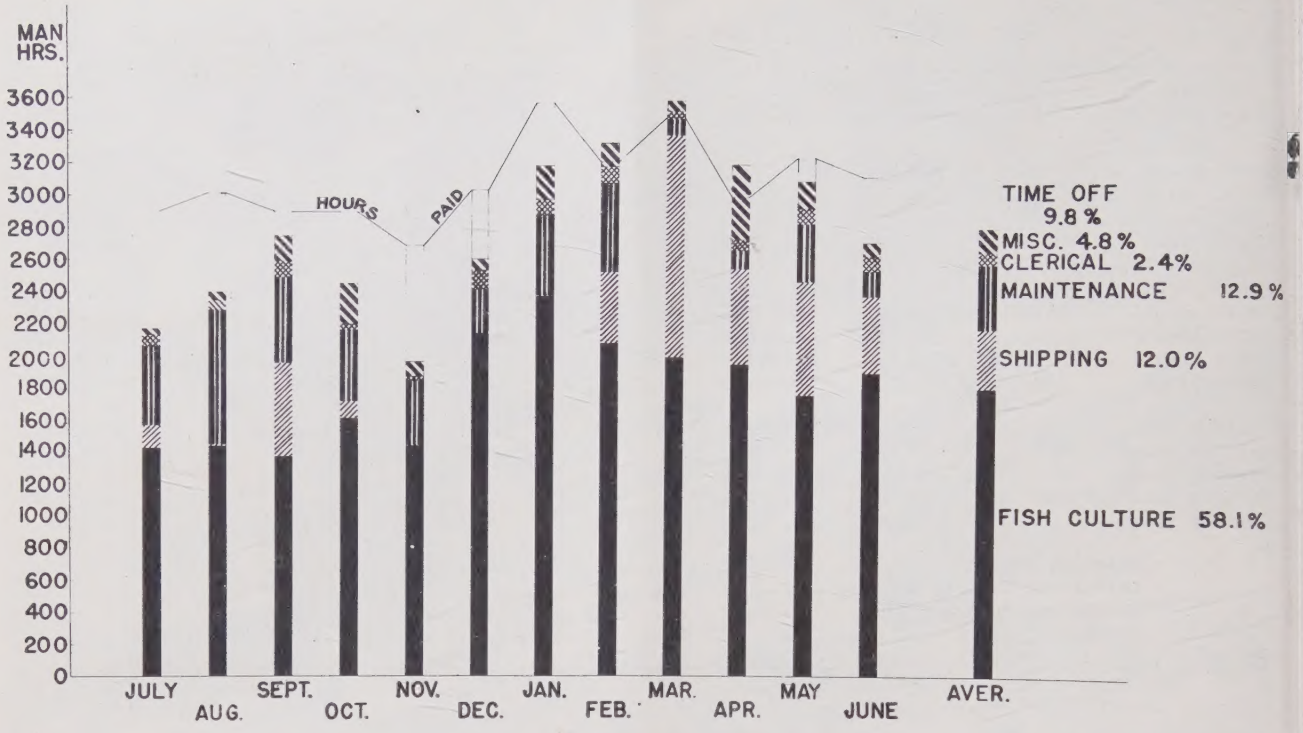


FIGURE 2.--Monthly variation in the six major items.

1-b. Cleaning Screens

A little thought has shown that the building of slat racks to replace screens in the ponds would soon pay for the effort of making them. This project has long been talked of but was put off because of lack of time. The building of the racks is now in progress. It is roughly estimated that not less than 25 percent of the time spent cleaning screens will be saved.

1-c. Transfers, Including Sorting

This item represents the time used in transferring fish from troughs to ponds and from pond to pond as the hatchery program progresses. A brief explanation of the transfers will be attempted. For this purpose the ponds may be divided into three groups according to their water supply: (1) spring water, (2) a mixture of spring and lake water, and (3) lake water. At the beginning of a calendar year, all of the first two groups of ponds are full of 1-year-old trout. About half of the lake-water ponds are full of 2-year-old trout, and the remainder are empty. The following transfers are made throughout the year:

1. In January, the yearlings in the upper eight spring-water ponds are transferred to lake-water ponds. Growth on these fish stops because the temperature of the lake water is 34°, but the move is necessary to provide spring-water ponds for fingerlings.

2. In February, fingerlings are stocked in the upper eight spring-water ponds.

3. In February, shipping is started from the remaining spring-water ponds.

4. In March, the fingerlings in the eight upper spring-water ponds are moved to the lower spring-water ponds (from which the yearlings have been shipped).

5. The upper spring-water ponds are restocked from the troughs.

6. All remaining yearlings (except those to be held for 2-year-olds) and 2-year-olds are now shipped.

7. In June, the fingerlings in the spring-water ponds are thinned and inventoried. After the thinning, they occupy all of the spring-water ponds and all of the ponds having a mixed supply of spring and lake water.

8. In October, an inventory is made of all fish on hand.

(Opposite)
FIGURE 3.--Division of hatchery activities.

FISH CULTURE AND SHIPMENTS 26,032.5	PONDS 7,597.0	FEEDING	2,177.5
		CLEANING SCREENS	2,100.0
		TRANSFERS, INCL. SORTING	1,517.5
		CLEANING PONDS	516.5
		PICKING LOSS	385.5
		SAMPLING	256.0
		MAKING & INSTALLING SCREENS	242.5
		REPAIR NETS	177.0
		WATER REGULATION	118.5
		MISCELLANEOUS	79.5
		MINNOW CULTURE	19.0
		POND REPAIR	7.5
	NIGHTWATCH	NIGHTWATCH	4,756.0
	SHIPMENTS 4,450.0	YEARLING & 2-YR. TRUCKING	2,188.0
		YEARLING & 2-YR. LOADING	996.5
		FINGERLING TRUCKING	970.0
		FINGERLING LOADING	295.5
	TROUGHS 3,946.0	FEEDING AND CLEANING	2,831.0
		INVENTORY AND THINNING	415.5
		PAINTING AND TARRING TROUGHS	227.0
		SCRUBBING	172.5
		SAMPLING	154.0
		TARRING SCREENS	110.0
		INSTALLING SCREENS	25.0
		SALTING	11.0
	FOOD PREPARATION & HANDLING 3,423.5	FOOD PREPARATION	2,950.0
		FOOD HANDLING	473.5
	SUNDAY WORK	SUNDAY WORK	1,308.0
	EGGS 552.0	PICKING	454.5
		UNPACKING, PUTTING ON TRAYS	68.5
		COUNTING	29.0
MAINTENANCE 4,797.0	CONSTRUCTION	PIPE LINES, GRADING, ETC.	1,526.5
	BUILDINGS 1,490.0	PAINTING, EXTERIOR	385.5
		CARPENTER WORK	355.0
		HOUSEKEEPING	250.5
		GENERAL REPAIRS	193.0
		REFRIGERATION REPAIRS	93.5
		PLUMBING	92.0
		ELECTRICAL	70.5
		PAINTING, INTERIOR	50.0
	AUTO. & OX. EQUIP. MAIN. 1,006.0	REPAIR TRUCKS	633.5
		REPAIR OXYGEN EQUIPMENT	332.5
		REPAIR GAS ENGINES	40.0
	GROUNDS 774.5	LAWNS	301.5
		GENERAL CLEAN-UP	193.5
		HAYING	189.5
		SNOW REMOVAL	46.0
		SHRUBBERY	44.0
CLERICAL 905.5	CLERICAL 905.5	REPORTS, CORRESPONDENCE	796.5
		STOCK ROOM, REC'P'T MATERIAL	109.0
MISCELLANEOUS 1,797.5	LOANED LABOR 591.0	TRUCKING FOR OTHER HATCHERY	464.0
		LOANED MAN	127.0
	EXPERIMENTAL	EXPERIMENTAL	229.5
	MISC. TRUCKING	DRIVING OTHER THAN SHIP.	220.5
	UNACCOUNTED FOR	UNACCOUNTED FOR	756.5
TIME OFF 3,629.5	TIME OFF 3,629.5	VACATION	2,720.0
		SICK LEAVE	702.0
		JURY DUTY	104.0
		INJURY, PAID TIME	103.5

This schedule involves an enormous transfer problem during the busy spring season. Most of the program is believed essential. In 1952, however, a plan is being tried to eliminate items 1 and 4, which in 1951 required 268½ man-hours during March.

Briefly, the change is as follows: The yearlings transferred in January to lake water are normally transferred late in February to another hatchery, where they are held for spring planting. The reason for holding them at Rome during the early part of the winter is a more favorable water temperature (45°, as compared with 37° at the other hatchery). This temperature advantage is nullified when the fish are transferred to lake water at Rome at 34°. Arrangements were made, therefore, to transfer these fish to the other hatchery in January.

To eliminate item 4, the stocking order of the spring-water ponds has been changed. Formerly the upper ponds have been stocked with fingerlings first; later, when the lower ponds were emptied, the fingerlings were moved from the upper to the lower ponds, and the upper ponds were restocked from the troughs. This procedure was initiated because of the proved fact that if fingerlings from troughs were stocked directly into the lower ponds, below fingerlings in the upper ponds, the fingerlings would contract gill disease. The new procedure is to empty the lower ponds of the series first. Lake water is turned on the eight upper ponds of yearlings, and this water is wasted at the end of the eight ponds. Spring water is supplied directly to the lower ponds and fingerlings are stocked in them. Later, when the upper ponds are emptied, the spring water is put through the entire series and fingerlings from the troughs are stocked in the upper ponds.

2. Nightwatch

This very large item almost defies reduction. Nightmen seem essential for the protection of the fish from theft, even without the more essential duty of cleaning screens. It has been considered that intensive pond cleaning and the use of racks might eliminate much or all of the screen cleaning, but just one plugged screen per year might easily cost an amount equal to the watchmen's annual pay. (The screen problem is unusually severe at Rome because when lake water is used in summer with a temperature in the seventies, large volumes are required.) The only logical solution seems to be to increase the nightmen's duties, as far as small regular assignments can be fitted into their schedule. As this work is unsupervised, the success depends to a large part on the individual man. In any case, the saving will not be great.

3-a, 3-b. Shipments

Every effort has been made to plan and execute the shipping schedule efficiently. On the other hand, more and more emphasis has been put on proper planting. No over-all saving here is contemplated, as any savings could profitably be spent on the planting operation.

3-c. Loading

Loading water and fish on the trucks requires one-half as much time as delivery and planting. We believe that our loading system is efficient, but further improvements may develop. No particular saving is anticipated. The labor of loading fish is biased in comparison to the delivery time: three nearby hatcheries come to Rome to secure fish for their areas, and for this no delivery time is charged to this hatchery.

4. Troughs--Feeding and Cleaning

This item refers to the 136 outdoor rearing troughs and 48 inside hatching troughs. In 1950, a substantial saving was made by eliminating use of covers on the outside troughs during January, February, and March. All snow shoveling and the raising and lowering of covers for feeding and cleaning were thus eliminated. It was found that after March the increased growth of algae, owing to the admission of sunlight, offset any advantage. It was proved by experiment that the trout grew equally well without covers, and--to our surprise--when transferred to ponds from uncovered troughs, the trout actually started feeding without the initial difficulties to which we were accustomed.

It is interesting to compare the time spent on troughs and ponds. This comparison is given in table 3. Trough culture is evidently nearly twice as expensive as pond culture. However, the fish reared in troughs include the fingerlings which are too small for ponds and require a great deal of care. In table 4 the labor cost of troughs is subdivided into costs for small fingerlings (December to June 30) and for advanced fingerlings (July 1 to November 30). The cost of rearing advanced fingerlings in troughs (0.476 man-hour per pound) is considerably more than the corresponding figure for ponds (0.344) but is far smaller than the cost of rearing small fingerlings in troughs (0.745).

TABLE 3.--Comparative labor required for troughs and ponds

	Ponds		Troughs	
Annual production, pounds	90,872		9,308	
	Man-hours	Man-hours per pound	Man-hours	Man-hours per pound
Labor, excluding shipments	7,597	0.084	3,946	0.423
Nightwatch	4,756	.052	0	0
Total direct labor	12,353	.136	3,946	.423
All other hatchery labor prorated to production		.208		.208
Total man-hours per pound produced		0.344		0.631

TABLE 4.--Comparative labor required for troughs to produce small fingerlings (December to June 30) and advanced fingerlings (July 1 to November 30)

	Small fingerlings	Large fingerlings
Pounds produced	5,419	3,889
Man-hours per pound, feeding and cleaning	0.417	0.148
Other trough labor not on a daily or monthly basis, such as annual maintenance, prorated per pound	.120	.120
Total man-hours per pound	.537	.268
All other hatchery labor prorated per pound all fish produced	.208	.208
Total man-hours per pound	0.745	0.476

Resuming the discussion of planned improvements, it is planned eventually to eliminate the rearing troughs and substitute concrete raceways 4 feet wide and 30 feet long. An experimental unit has shown that these are equally satisfactory for fry, and they are somewhat easier to care for. The annual maintenance will also be less.

An important aid in more evenly dividing the spring work load has resulted from the use of light control in producing early eggs. In the 1951-52 season, the peak of the small fingerling care and the transfer of a large proportion to ponds will occur before the start of the shipping season. This will greatly reduce the work load in March and April. However, figure 3 shows that the time spent in scrubbing the troughs and treating the fish is very small. More time should be devoted to both these items, but it has been impossible because this need has coincided with the shipping season.

5. Feed Preparation

A general trend in fish culture is toward the use of pellets for advanced fingerlings and older fish. Pellet feeding has been started at Rome. The food preparation has, of course, been substantially reduced.

6. Sunday Work

On Sundays, all fingerlings are cared for as on the weekdays. Other necessary work is performed. A labor crew of two to four men, depending on the season, is provided so that all required work may easily be accomplished. No savings are immediately anticipated, but it is proposed to test in 1952 the effect of increasing the weekday feed of fingerlings and eliminating Sunday feeding after they reach 3½ inches.

The labor changes which have been discussed should amount to a considerable saving. A further effort will be required to see that this time is allocated to the most needful tasks rather than to doing a better job at the things which are now well done.

OTHER COMPARISONS

The accumulated data may be used for many additional comparisons. Only a few will be discussed.

The Rome Hatchery is operated in accordance with the methods of the New York State Feeding Chart (Deuel et al. 1942). It has been asked what additional labor cost was required by this system. Two items are involved: first,

TIME STUDY AT ROME HATCHERY: July 1, 1950, to June 30, 1951

		July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
								(Hours)						
	Ponds													
041	Feeding	146	233	200½	172½	104	152½	221½	252	198½	179	176½	139½	2,177½
045	Cleaning screens	150	136	188	290	210½	183½	91	150½	197	189½	161½	142½	2,100
043	Transfers, including sorting	85½	0	20	74½	40½	341½	66½	100	102	206½	140½	340	1,517½
042	Cleaning	8	0	0	8	0	1½	93½	72½	47	96	22	168	516½
049	Picking loss	0	0	0	0	0	0	0	61½	156	83½	65	19½	385½
048	Sampling	14	10	15	32	8	35	13½	15	39	22½	32	20	256
046	Making and installing screens	3½	12½	0	20	61½	30½	52	2	8	13	16½	23	242½
077	Repair nets	29	9	24	4	0	3	39	23	4	9	18	15	177
014	Water regulation	2	8½	3	12	0	22	24½	18	9	8	10½	1	118½
047	Miscellaneous	3	3	5	21½	0	1½	23	12	3	4	1½	2	79½
047.1	Minnow culture	0	0	0	0	0	0	0	0	0	0	9	10	19
072	Repairs to ponds	0	5½	0	0	0	0	0	0	2	0	0	0	7½
		451	417½	455½	634½	424½	771	624½	706½	765½	811	655	880½	7,597
	Nightwatch													
	Nightwatch	404	425	396	411	406	390	418½	368½	338½	399	407	392½	4,756
		404	425	396	411	406	390	418½	368½	338½	399	407	392½	4,756
	Shipments													
053	Y and 2Y trucking	94½	6½	14	0	0	0	0	271½	983	377	397½	44	2,188
054	Y and 2Y loading	37½	2	0	0	0	0	0	156½	321	220	198½	61	996½
051	Fingerling trucking	0	0	484½	97	0	0	0	0	41½	0	63	284	970
052	Fingerling loading	7	1	85	10½	3½	0	3	18	33	0	47½	87	295½
		139	9½	583½	107½	3½	0	3	446	1,378½	597	706½	476	4,450
	Troughs													
031	Feeding and cleaning	99	150½	139	106½	82	232½	521	415½	328	279½	267½	210	2,831
033	Inventorying and thinning	32	1½	0	0	1½	30	30½	66	45½	100½	57	51	415½
075	Painting and tarring troughs	0	18	31	0	0	0	170	8	0	0	0	0	227
032	Scrubbing	20	21	0	0	17	30	6	10½	47½	12½	4	4	172½
034	Sampling	0	32	0	0	0	21	37	29	16	2	13	4	154
074	Tarring screens	0	8	18½	15½	22	2	44	0	0	0	0	0	110
035	Installing screens	0	0	0	0	0	2	7	9	4	0	3	0	25
036	Salting	0	0	0	0	0	0	0	11	0	0	0	0	11
		151	231	188½	122	122½	317½	815½	549	441	194½	344½	269	3,946
	Food													
091	Preparing food	281½	245	195½	279½	199½	229	324½	327	253	213	203	199½	2,950
093	Food handling	42½	73	60	57	29½	32½	15	10½	92	12	19	30½	473½
		324	318	255½	336½	229	261½	339½	337½	345	225	222	230	3,423½
	Construction													
073	Pipe lines, grading, etc.	89½	261	340	244	367½	49	19½	6	0	0	140	10	1,526½
		89½	261	340	244	367½	49	19½	6	0	0	140	10	1,526½

TIME STUDY AT ROME HATCHERY: July 1, 1950, to June 30, 1951 (Continued)

		July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. (Hours)	Feb.	Mar.	Apr.	May	June	Total
	Buildings													
071.2	Painting, exterior	72½	194	14½	86½	2	0	4	0	0	0	12	0	385½
071.3	Carpenter work	0	88	16	5½	8	26	76½	107½	4	10	8	5½	355
012	Housekeeping	42½	40½	13½	6½	6½	3½	40½	52½	12½	4	25	3	250½
076	Repairs, general	43½	7½	9	0	0	30½	68½	27½	4½	1	1	0	193
071.6	Refrigeration repairs	3½	18	8	4½	4½	28	6	1	0	7½	1½	11	93½
071.5	Plumbing	7	20	0	11	2	0	52	0	0	0	0	0	92
071.4	Electrical	4	5	8½	5	0	3	31	4	0	0	6	4	70½
071.1	Painting, interior	19	23	8	0	0	0	0	0	0	0	0	0	50
		192	396	77½	119	23	91	278½	192½	21	22½	53½	23½	1,490
	Sunday Work													
103	Sunday work	102	52	86	68½	76½	137½	152	128	112	128	136	129½	1,308
		102	52	86	68½	76½	137½	152	128	112	128	136	129½	1,308
	Auto. & Ox. Equip. Main.													
081.1	Repair trucks	4	14	26	8	10	77	117	225	59	40	27	26½	633½
081.2	Repair oxygen equipment	62	6	50½	9	0	0	56	109	16	3	11	10	332½
081.3	Repair gas engines	18½	18	½	0	0	0	0	0	0	0	3	0	40
		84½	38	77	17	10	77	173	334	75	43	41	36½	1,006
	Clerical													
011	Reports, correspondence	63	57	93	20½	26½	100½	59	86½	50	58	91	91½	796½
013	Stock room, rec'pt. material	7	5	6	14½	2	17	35½	10½	0	6½	3	2	109
		70	62	99	35	28½	117½	94½	97	50	64½	94	93½	905½
	Grounds and Shrubbery													
061	Lawns	60½	52	25½	20	0	0	0	0	0	10	91½	42	301½
066	General Clean up	27	22	0	48	2	27	17	8	3½	29	7	3	193½
063	Haying	32	65½	17	0	0	0	0	0	0	4	28	43	189½
067	Snow removal	0	0	0	0	0	19	17	10	0	0	0	0	46
065	Shrubbery	14	8	0	0	2	13	0	0	0	7	0	0	44
		133½	147½	42½	68	4	59	34	18	3½	50	126½	88	774½
	Loaned Labor													
055	Trucking for other hatchery	0	0	88½	76	0	0	0	0	0	268½	23	8	464
106	Loaned man	0	0	0	0	0	0	0	0	0	89	28	10	127
		0	0	88½	76	0	0	0	0	0	357½	51	18	591
	Eggs													
021	Picking, etc.	0	0	0	27½	144½	253½	29	0	0	0	0	0	454½
023	Unpacking, putting on trays	0	0	0	15	40½	13	0	0	0	0	0	0	68½
022	Counting samples	0	0	0	6	6	11	6	0	0	0	0	0	29
		0	0	0	48½	191	277½	35	0	0	0	0	0	552

TIME STUDY AT ROME HATCHERY: July 1, 1950, to June 30, 1951 (Continued)

		July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. (Hours)	Feb.	Mar.	Apr.	May	June	Total
	Experimental													
111	Experimental	12	26	54½	50	0	0	51	27	0	0	0	9	229½
		12	26	54½	50	0	0	51	27	0	0	0	9	229½
	Truck Driving													
082	Driving other than shipments	3	0	10	36	12	9½	32½	37½	5½	14	40½	20	220½
		3	0	10	36	12	9½	32½	37½	5½	14	40½	20	220½
	Unaccounted for	22½	24½	6	91	78	62	125	80½	58½	94	78½	36	756½
TOTAL HOURS SPENT		2,179	2,408	2,760	2,464½	1,976	2,620	3,196	3,328	3,594	3,200	3,096	2,712	33,532½
	Time taken off (vacation)	600	612	144	384	736	348	216	8	56	0	224	432	2,720
	Extra time worked	0	0	0	16	32	32	8	184	336	280	128	24	
	Sick leave	134	4	8	24	8	96	76	64	160	80	48	0	702
	Jury duty	0	0	0	0	0	0	104	0	0	0	0	0	104
	Injury - paid time	0	0	0	55½	16	16	0	0	16	0	0	0	103½
TOTAL HOURS PAID		2,912	3,024	2,912	2,912	2,704	3,048	3,584	3,216	3,490	3,000	3,240	3,120	37,162

the sampling of the ponds and troughs, which requires 410 man-hours per year; and second, the clerical work. The latter has been overestimated as two-thirds of the total clerical work, or 531 man-hours per year. A total of 941 man-hours is thus charged against the chart. This represents 0.0094 man-hour per pound produced, or less than 1 cent per pound. The savings in fish food and general hatchery management by the use of the chart will more than offset this cost.

Throughout the collection of the data, the writer has been amazed at many of the results which were entirely contrary to his expectations. There is a good and now-obvious reason for misconceptions. For example, it was expected that the item for the transfer of fish from troughs to ponds and from pond to pond, including inventorying, would be much larger than the 5.2 percent of the total which it actually is. The fallacy in expecting this item to be larger will be shown by a typical day during the fall when inventorying, sorting, and transferring made up the "principal activity." On this day the labor division was as follows:

Transfers and sorting			28
Picking eggs	22		
Nightwatch	14		
Cleaning screens	8		
Feeding ponds	8		
Preparing food	8	67	111
Feeding and cleaning troughs	4		
Shrubbery	3		
Vacation	8		
Sickness	8	16	

The "major job" for the day was a small item when compared to the routine activity--which was underestimated. This same line of reasoning may lead to erroneous conceptions of other jobs. For example, since the installation of a central cold-storage plant it has seemed that almost every day a truck comes in from another hatchery for feed, and a large amount of time is thus spent. However, the total time spent in food handling (including our own) is 473½ hours per year, or 1.3 percent of the total.

In conclusion, to those to whom our data may seem all too obvious, we may state that they weren't obvious to us until after the study.

SUMMARY AND CONCLUSIONS

1. Efficient management requires that there be an over-all plan and schedule for

the year's operation. Such a schedule may be mental or written, but it should be detailed. It must be flexible. In fact, one of its principal purposes is to have something concrete upon which to improve.

2. The management plan should be discussed thoroughly with the supervisors, who may have useful suggestions. The discussion may be piecemeal and informal, but in total it should cover the entire plan. It is often necessary for the supervisor to make decisions for the hatchery, involving its schedule. Such decisions may well be influenced by his knowledge of the plan.

3. An important item in efficient labor utilization is personnel relations. No employee complaint should remain unsettled. In addition, the hatchery employee should be made a part of management by explaining to him the reasons for various steps, and careful consideration should be given to his suggestions.

4. Working conditions should be improved to the maximum possible extent. The reward in good will may not be great, as most of the outside work required even in bad weather cannot be eliminated.

5. The plant lay-out should be studied for inherent inefficiencies. In particular, the piping plan should be studied. It is not sufficient to have pipes to take water where it is needed. Often an additional pipe line, although not required, will permit flexibility of operation which will have great benefit.

6. Possibilities for mechanization should be fully explored. Fish hatcheries are far behind industry in this respect.

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MODIFICATION OF THE HYDRAULIC PRESS FOR MAKING IMPRESSIONS OF FISH SCALES

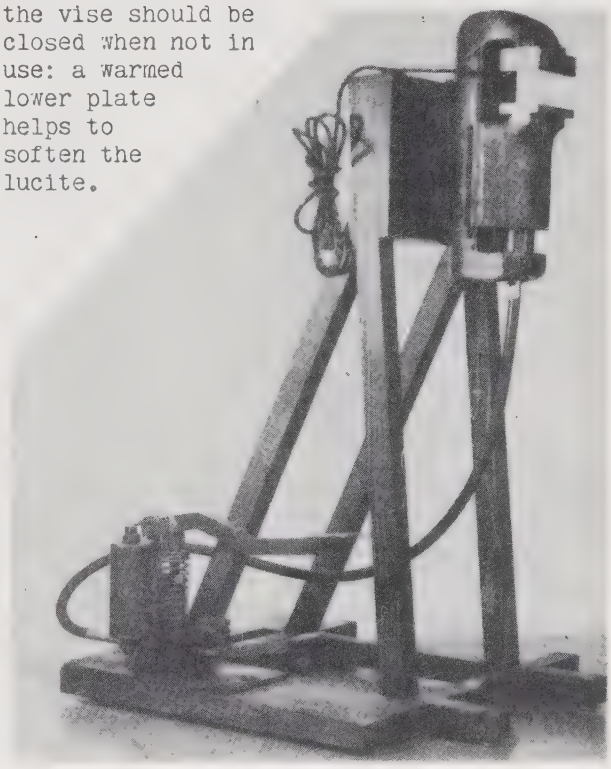
SOME MODIFICATION of the hydraulic press described by Greenbank and O'Donnell at the 78th meeting of the American Fisheries Society has been suggested by Laurence E. Hiner of the Fish and Wildlife Service.

Two milled, polished, mild steel dies or contact plates (2½ by 4½ by ½ inch) have replaced the original jaws on a 4-ton Reimuller hydraulic vise. The upper plate has a heating element (an electric coffee-percolator unit). The vise is mounted vertically, the open jaws at table height. The hydraulic cylinder at the base of the frame has foot levers for compression and release.

When four or more scales are placed, sculptured side down, on a lucite plastic slide (0.04 inch thick, about the size of a glass microscope slide), the lower jaw of the vise is pressed against the preheated upper jaw.

Large, thick scales usually need temperatures of 300° to 400° F.; small, thin scales, about 200°. Ordinarily impressions can be made in 1 to 2 seconds.

Best results are secured if the temperature of the heated plate is high and the slide is in the vise only a minimum time. If large or thick scales are being pressed, the jaws of the vise should be closed when not in use: a warmed lower plate helps to soften the lucite.



PUBLIC SENTIMENT: AN IMPORTANT FACTOR IN FISHERY MANAGEMENT,

With Special Reference to the St. Johns River and Lake Okeechobee, Florida

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A NUMBER OF THE PROBLEMS that are involved in the management of the fisheries of the St. Johns River and Lake Okeechobee have already been presented (Dequine 1950). Since that presentation, some of those problems have been solved, but one of the major difficulties has yet to be overcome. Briefly, the problem deals with a burning controversy between sportsmen and commercial fishermen.

HISTORY

Before 1946, the commercial taking and sale of bream (a term commonly applied to most sunfishes), crappie, and catfish had been legal in the northern half of the St. Johns River and in Lake Okeechobee. Sportsmen convinced the Game and Fresh Water Fish Commission, however, that the use of seines and other commercial fishing devices should be stopped, and that the bream and crappie should be removed from the commercial list. This action was taken with no regard for a report based upon a brief survey of the waters by fishery biologists of the Marine Biological Laboratory of the University of Miami and recommending that the commercial fisheries continue until a thorough study of the problem could be made (Marshall 1946--mimeographed). The termination of the commercial activities did not solve the problem. Some commercial fishermen continued to "bootleg" illegally taken bream and crappie across the State line, creating an enforcement problem with which the Commission could not cope--partly because of the lack of necessary legislation. Other commercial interests and many sportsmen in the affected areas continued to express concern that stopping the removal of bream, crappie, and catfish would not only remove an economic asset of the areas (which had supported commercial fishing operations more than 60 years with no valid evidence of depletion) but would also result in a decline in the populations of black bass for which both areas were noted.

THE SURVEY

The stand of this latter group resulted in the establishment in mid-1948 of a survey program, under the direction of the writer, allowing the use of haul seines under the immediate supervision of Commission fishery technicians to accomplish three major objectives: (1) to determine the effect of commercial fishing operations upon game-fish populations and sport fishing, (2) to discover the potentialities of the commercial fisheries, and (3) to level partially the disrupted economy of the areas affected by the ban on commercial fishing. Under this program, commercial fishermen were allowed to take catfish and other rough fish but were required to return all game fish and to assist the biologists in obtaining data from their catches. At the time of its inception, this plan had the backing of the chief representatives of both opposing groups.

The principal areas included in the survey were Lake Okeechobee, that part of the St. Johns River known as Lake George, and connecting waters in the immediate vicinity, all of which had been major locations of freshwater commercial and sport fisheries since their settlement. In addition, it was possible to make similar studies in other large Florida lakes in connection with rough-fish control operations. Effort was concentrated upon learning the species composition of the adult fish population through the medium of the haul seine, the composition of the catch by various commercial fishing devices and their probable effect on game-fish populations, age, growth, and food habits of the

dominant species, and creel-census data. The methods used and results obtained have already been reported (Dequine 1948, 1951a; 1951b--mimeographed).

RESULTS OF INVESTIGATIONS

The major conclusions after almost three years of investigation were that:

1. Considerable fluctuation in seasonal and annual composition of the adult fish populations occurred, but these fluctuations could not be attributed to commercial fishing operations.

2. The life span of the black bass, the black crappie, the bluegill, and the redear (shellcracker) was comparatively short; an almost complete replacement and turnover occurred within two to three years.

3. Black bass, adult crappie, gar, bowfin, and large channel catfish were piscivorous, in direct competition for the available supply of forage fishes; bluegill, redear (shellcracker), bullheads, and small channel catfish competed for the available aquatic insects and other foods used in common; large gizzard shad made up a significant proportion of the population, and though their effect was not so noticeable in Lakes George and Okeechobee, they were definitely found suppressing desirable species in other waters studied.

4. Though no harmful effects of commercial fishing operations on game-fish populations and angling were evident, it was impossible to denote any significantly beneficial effects during the period studied.

5. Past records on the commercial fishery for catfish, bream, and crappie showed considerable variance in annual production; but no over-all decline had occurred. Market and other economic conditions and weather had the greatest influence on the annual yields of the fishery, as indicated by statements and records of reliable fishermen. Conservatively estimated potential annual yields of the commercial fisheries were: 100 to 400 thousand pounds of black crappie, 100 to 700 thousand pounds of bream, and 2.5 to 3 million pounds of catfish from the St. Johns River; and 200 to 500 thousand pounds of crappie, 300 to 500 thousand pounds of bream, and 1.5 to 2 million pounds of catfish from Lake Okeechobee.

6. No valid data were obtained to indicate a reduction in the total annual yield of black bass to the angler, although an increase of three to four times the amount of angling pressure over recent years was reflected in increased fishing license sales and in expansion of fishing camps and other angling facilities available in the areas considered. Creel-census data revealed that more than 90 percent of the effort of the angler in the Lake George-Okeechobee areas was expended toward catching black bass.

7. A review of opinions of fishery scientists and available data on experimental control of species other than those desired by the angler indicated that benefit to black bass production and angling would accrue from the commercial removal of all other species.

These conclusions, with supporting data and detailed recommendations for the management of the commercial fisheries, were presented in a report to the Commission in July 1950. Some of the former opponents of commercial fishing violently protested, although at the time of the inception of the survey they had agreed to abide by its outcome. Objections and feelings ran so high among one extremely vocal group of "sportsmen" that they castigated not only the professional competency of the writer and his assistants, but their integrity and character as well. As a result, the Commission (at the suggestion of this writer) submitted the report to a panel of disinterested, nationally known fishery scientists to determine whether the conclusions reached in the survey were valid. This panel, composed of R. W. Eschmeyer, O. Lloyd Meehean, F. G. Walton Smith, and H. S. Swingle, unanimously endorsed the presentation of the data and the conclusions reached; the panel urged that the recommendations be put into effect with a continuation of the investigation. Many other fishery workers among whom the report was circulated made similar comments. The same violent opponents then countered that fishery workers as a group are prejudiced in favor of commercial fisheries--and reverted to demanding restocking and more law enforcement as a cure for Florida's fishing ills.

Fortunately, these opponents do not represent the whole, nor even a majority, of the angling public of Florida, although until recently they have been the loudest. Many other groups of sportsmen are requesting that the commercialization of the bream and crappie be legalized again and extended to waters other than Lake George and Lake Okeechobee on a trial basis to determine whether improved bass fishing will result. Considerable effort has been expended in educational programs in some localities, and--presumably as a result--this sentiment appears to be spreading.

PRESENT STATUS OF FLORIDA'S PROBLEM

On February 4, 1952, after many public

RIGHT: During haul seine surveys, a fish-management technician supervised operations, recording the number, composition, and average weight of the dip-nets of fish returned to the water.

BELOW: Bailing fish out of the pocket of the seine. Bluegill, shellcracker, and black crappie are prominent.

Longnose gar, channel and white catfish, speckled bullhead, gizzard shad, and other rough fish taken by seine from a Florida lake.

(All photos by Tony Stevens, Florida Game and Fresh Water Fish Commission.)

hearings and postponements, the Commission voted to restore the seining and sale (under strict controls) of bream, crappie, and catfish from a portion of the St. Johns River and Lake Okeechobee, and to set up three other lakes on an experimental basis for the purpose of determining the effect of such a program upon sport fishing. "Sportsmen" opponents of the plan threaten to take every possible means to block the execution of the program, and another round of legal battles is anticipated at this writing.

THE PROBLEM OF PUBLIC SENTIMENT

The problem of public antagonism toward the harvesting of surplus game and rough fishes and toward commercial fishing in general is not a problem that is confined to Florida. Fishery workers in Illinois (Bennett 1951), Michigan (Westerman 1948, Van Oosten 1939), Tennessee (Eschmeyer, Stroud, and Jones, 1944; Manges 1951), Alabama (Miller 1951, Swingle 1950), Iowa (Rose 1949), Indiana (Ricker and Gottschalk 1941), and Texas (Marion Toole, personal communication, 1950) are among those who have suggested that regulated harvest by commercial methods of species not extensively used by the angler would provide better fish conservation. Replies to a questionnaire recently sent by the writer to State fishery managers indicated that many others possess evidence sufficient to convince them that such action is desirable, but adverse public sentiment prevents its application.

To the fishery manager, the problem presents a number of important questions and challenges that seem worthy of discussion. What are the causes of this apparently overwhelming public disapproval of commercial fishing? Indubitably, the commercial fisherman himself is to blame in a large degree. The dumping of edible fish during adverse market conditions, the thoughtless destruction of undersized or less valuable species taken in certain fisheries, and the fisherman's disdain in many instances for regulations aimed at perpetuating his own industry have incurred the wrath of conservationists generally. In short, his attitude of exploiting rather than harvesting wisely has placed him in disrepute.

Also at fault are some writers, commentators, and columnists on outdoor subjects. Some of these men, whose popularity and livelihood depend on a good audience, have found that "cussing the commercial fisherman" gains the sympathy of their public. Few publicists in this category have taken the trouble to inform themselves of the facts regarding commercial fishing and fishery biology, and some resist any attempt to educate them through demonstration, research, or statistics.

A fair-sized finger of guilt can be pointed at many professional fishery technicians, who have found it convenient to follow the popular idea of condemning commercialization without thorough investigation, or to reach so-called "logical" conclusions regarding the decline of fishing success. Some years ago, Van Oosten (1935) pointed out that certain "logical" deductions concerning the selectivity of fishing gear, fishery statistics, and effects of pollution were not justified when subjected to relatively uncomplicated research. Many other programs such as the indiscriminate stocking of hatchery fish, fish rescue, closed seasons, and size limits have only recently been critically analyzed, and their limitations defined. Is there any wonder that the profession lacks the confidence of the public when it is faced with so many contradictions in policy? Certainly lack of funds for conducting tests on the effectiveness of these programs cannot be a valid excuse for dodging our responsibility for many of these errors.

SUGGESTED METHODS OF APPROACH

If it is assumed that controlled commercialization is a necessary and desirable tool for promoting better fish conservation, how can the adverse public sentiment be overcome? The obvious answer, by education, provides a major challenge to the fishery manager. The commercial fisherman, generally unreceptive to magazine articles and other literature, must be convinced that his excesses and his disregard for regulations are largely responsible for his present plight. He must be shown the necessity for the restrictions imposed upon him by persons who are as familiar with his industry as he is, and who can demonstrate that these laws are based upon data obtained from his operations and not upon "logical" deductions which are often refuted by his experience. To accomplish this objective, the fishery manager needs an intimate knowledge of the fishery and personal contacts with many of its participants.

For the sportsman-publicist, a special effort must be made through personal contact and demonstration of an intimate knowledge of his interests, as well as those of the commercial fisherman. Sufficient irrefutable facts must be available and well presented; controversial points must be clearly defined with as few qualifications as possible. The fishery manager must understand the problems of the writer or commentator in supplying

his audience with information that has public appeal.

The fishery biologist must learn from past example that his proposed management practices must be based upon facts and conclusions that have been thoroughly analyzed and critically examined. If he examines carefully the reasons for the enactment of restrictive commercial fishing regulations, he will find that frequently there was little valid evidence of depletion due to overfishing available at the time of enactment, but that "logical" deductions, sentiment and opinions, and an absence of facts about the effect of commercial fishing were largely responsible. He must ever be aware of the possibility that his conclusions may be immature and subject to correction and modification. Armed with these data, he must embark upon an educational program that makes use of every possible outlet--press, radio, public demonstrations, and personal contacts.

CONCLUSIONS

The modern fishery manager cannot confine his activities to gathering facts, drawing conclusions, and making recommendations. He must, in addition, become a salesman and an educator if he is to accomplish his objective, whether it be removal of an unnecessary regulation, adoption of a new program, or other. The problem of creating favorable public sentiment must be attacked with the same vigor and care applied to a fish-population analysis, a food-habits study, or a creel census.

In Florida, fishery biologists are convinced that controlled commercial fishing operations form the only practical method available to provide more successful fishing trips and better utilization of the fishery resources of the State's large natural fresh waters. Greater emphasis on educating the public to the facts supporting this conviction is planned. It is hoped that Florida's experience with this difficult problem will be of value to workers elsewhere.

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OBSERVATIONS ON COLUMNARIS IN SALMON AND TROUT

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A SERIES OF EXPERIMENTS designed to study the use of impounded water in the fish-cultural operations at the Dorena Dam Experimental Laboratory of the Fish and Wildlife Service at Cottage Grove, Oregon, provided an opportunity to observe the effects of water temperatures on an infection of columnaris in salmon and trout during the summer of 1951. Some limited experiments were conducted with sulfa drugs in the control of the disease.

Columnaris disease caused by the myxobacterium Chondrococcus columnaris (Davis) has been described from warm-water fish in the Mississippi Valley (Davis 1922); blueback, chinook and silver salmon, and steelhead trout in Washington (Fish and Rucker 1945); brook trout in West Virginia (Davis 1946); chinook salmon in California (Slater 1948); and steelhead trout in California (Johnson 1951). Many of these writers noted that the course of a columnaris infection was influenced by water temperatures. Fish and Rucker, working with blueback salmon fingerlings held in water of controlled temperature and exposed to cultures of C. columnaris, wrote:

> ... data acquired from controlled infection experiments indicate that among cold-water fishes, columnaris disease is of little consequence to fingerlings below 55° F. but that it becomes extremely virulent at temperatures in excess of 70° F. ...

They were unable to control the disease with several external disinfectants. Both Slater and Johnson reported some success in control measures with sulfa drugs.

In the early spring, when most of the danger of flood is past, Dorena Reservoir, a flood-control project of the U. S. Corps of Engineers, is allowed to fill until a surface elevation of 833 feet above sea level has been reached during May. At this reservoir stage, the water depth at the concrete spillway section of the dam is approximately 100 feet. The water level gradually drops throughout the summer and reaches a surface elevation of about 825 feet in September, when rapid evacuation of the reservoir is started to provide storage space for winter floods.

From April to October 1951, water from three levels (765-, 785-, and 805-foot elevations) in Dorena Reservoir was available in the laboratory. After a thermocline developed in the reservoir early in the summer, the intake at the upper (805-foot) level supplied relatively warm water from the epilimnion, while the intake at the lower (765-foot) level supplied colder water from the hypolimnion. The thermocline was near the middle (785-foot) intake for much of the summer.

During summer and fall, fingerling spring chinook salmon (Oncorhynchus tschawytscha), silver salmon (O. kisutch), cutthroat trout (Salmo clarkii), and rainbow trout (S. gairdnerii) were reared in water from the upper intake, in water from the lower intake, and in a mixed supply of water. It was planned to maintain this mixed supply of water at a temperature of 55° to 60° F. by using water from any or all intakes as required. The weekly maximum and minimum temperatures of each of the water supplies used are shown in figure 1. It will be noted that in June the maximum temperature of the mixed supply rose considerably higher than the desired 60°. This inadvertent rise in temperature, which lasted for about 3 weeks, was corrected by mixing in colder water. After June 26 the temperature of this supply did not go above 63° F.

The young salmon in these experiments were reared in circular tanks, 6 feet in diameter and containing water 1 foot in depth. The 12 tanks which held spring chinook salmon were divided into sections of 4 tanks. Each section received one of the three water supplies used. For two of the tanks in each section, the water was piped direct to the tanks; for the remaining two tanks, the water was passed through a large aerator near the

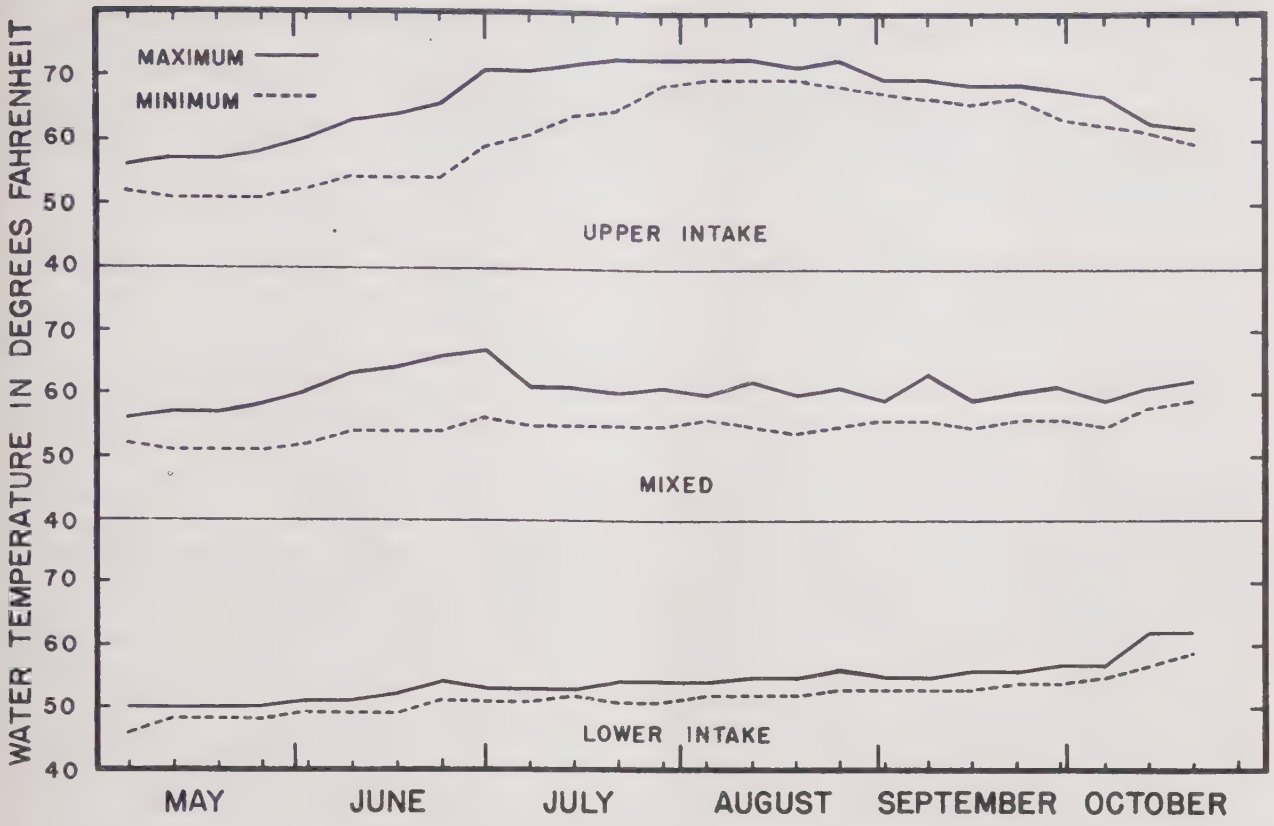

FIGURE 1.--Weekly maximum and minimum temperatures (in degrees Fahrenheit) for three water supplies, May-October 1951.

hatchery building. (Hereafter, water passed through the aerator will be called "aerated" and the water piped direct will be called "unaerated.") Twelve tanks of fingerling silver salmon were handled in the same manner as the chinooks. The rainbow and cutthroat trout were held in deep hatchery troughs, 16 feet long, 16 inches wide, and holding 10 inches of water. Four troughs of each species of trout received upper-intake water, four of each species received mixed water, and three of each received lower-intake water.

The sulfamerazine used in disease treatments was in the powdered form and was labeled for veterinary use. The drug was mixed in the food at the rate of 6 or 12 grams daily per 100 pounds of fish to be fed. The entire daily dose was mixed with the day's feed, which was given to the fish in two portions at about 9:00 a.m. and 4:00 p.m.

Cultures of kidney tissue were made from salmon and trout which had obvious external lesions, and the causative bacterium C. columnaris was recovered from fish of each species.

Observations on the course of the disease and the effects of treatments will be covered separately for each species of fish handled.

SPRING CHINOOK SALMON

In April, one lot of small fingerling spring chinook salmon was divided equally and at random into 12 rearing tanks that had three water supplies as previously discussed. These fish were held in these tanks until October.

The mortalities of the fish held in the cool lower-intake water were less than 2 percent (table 1) during the entire period, and no indication of columnaris was seen on any of the fish in these four tanks.

On June 26, gill lesions of columnaris were found on dead and moribund salmon in the two tanks receiving unaerated mixed water. All mixed water had had daily maximum temperatures of more than 60° F. for the previous 19 days, with a maximum of 67° on June 26. Immediately after the disease was discovered, colder water was introduced into these tanks; and the daily maximum temperatures were held near 60° F. for the remainder of the experiment. This lowered water temperature had no immediate effect on the mortality, which remained high for more than a month and then gradually declined. The infecting bacteria

TABLE 1.—Percentage mortality and sulfamerazine treatments in individual tanks or troughs of fingerling salmon and trout during summer and fall of 1951

Species	Percentage mortality and sulfamerazine (S) treatment in											
	Lower-intake water				Mixed water				Upper-intake water			
	Aerated		Unaerated		Aerated		Unaerated		Aerated		Unaerated	
Spring chinook salmon	1.8	2.5	0.8	1.1	2.2	4.7	15.5	8.4	56.0 (S)	47.9	60.1 (S)	58.3
Silver salmon	0.5	0.3	0.5	0.2	0.7	0.4	0.8	0.6	18.4 (S)	74.1	38.4 (S)	70.0
Cutthroat trout	-	0.6	0.7	1.2	6.1	0.8	4.5	0.7	82.0	42.3	45.5 (S)	36.9 (S)
Rainbow trout	-	4.1	3.5	4.4	9.0	6.4	11.0	6.9	37.5	41.2	16.5 (S)	22.1 (S)

were never eliminated: this was indicated by the fact that some salmon with typical lesions were still found at the close of the test in October. The total mortalities in these two tanks which received the unaerated mixed water were 15.5 percent and 8.4 percent. The other tanks in this section were supplied with the same mixed water except that it was aerated. The columnaris infection was not observed in these tanks until September, and then only a very few fish were affected. The mortalities for the season were 2.2 percent and 4.7 percent in these two tanks. As this was the only instance in which there was any great difference between mortalities of fish held in aerated water and mortalities of fish held in unaerated water, it is believed that difference in losses was due to the natural irregularity of appearance of this disease rather than to aeration. Except for the change in water temperature in June, no disease treatments were given and no attempts were made to arrest the course of the infection.

The spring chinook salmon in the tanks supplied with upper-intake water (which was identical with the mixed water until after June 26) developed the columnaris infection about the first of July, and the mortality rapidly mounted in both aerated and unaerated water. Maximum daily temperatures were 70° F. or higher throughout most of July and August; during all of August, the minimum daily temperatures of upper-intake water never dropped below 69° F. These temperatures appeared ideal for the growth of the bacteria, and mortalities were extremely high.

On July 6, treatments with sulfamerazine were started on one tank of salmon on aerated upper-intake water and on one tank receiving unaerated upper-intake water. One tank on each supply remained untreated as the control. The treated fish were fed the drug at the 12-gram rate for 1 week, at the 6-gram rate for 2 weeks, and again at the 12-gram rate for the following 4 weeks, after which all treatments were discontinued. Initially it appeared that the drug controlled the disease, as there was a marked decrease in mortality in the treated groups while the losses in the controls increased. Although the mortalities were reduced, the infection was not eliminated; and even after 3 weeks of treatment, most of the fish that died had typical lesions of columnaris. The daily dosage was then increased to 12 grams per 100 pounds of fish, but the mortalities continued and soon rose to new heights while the losses of the untreated controls gradually increased. This peak in mortality of treated salmon occurred about 2 weeks later in one tank than in the other, but they suffered losses of the same magnitude. Late in August, mortalities in all tanks receiving upper-intake water decreased markedly. All treatments were terminated on August 23. As the water temperatures were still near 70° F. when mortalities decreased, it is believed that either all susceptible fish had died or the survivors had had only a minor infection and had acquired immunity. The total mortalities for the entire period were 60.1 percent and 56.0 percent in the tanks of treated chinook salmon and 58.3 percent and 47.9 percent in the tanks of untreated fish, indicating that the 7 weeks of sulfamerazine treatments were of no benefit to the young salmon.

At the start and during the height of the epizootic, the typical lesion of the columnaris infection was on the gills of the fingerling spring chinook salmon. After the infection had run its course, a few fish with tail, fin, or head lesions were observed. In the early stages, the gill lesion consisted of a pale-gray or white area on the ends of several gill filaments. This spot was about

a quarter of an inch in diameter and was very distinct from the adjacent gill filaments which had the normal deep-red color. In the later stages, the gill filaments involved became severely eroded; often a semicircular portion of the gill filaments, half an inch across, was entirely destroyed. The edges of the lesion were usually a dirty-gray or tan color, probably from accumulation of silt on the disintegrating tissues. The remainder of the gill appeared normal, showing no fusion of lamellae or filaments as seen in gill disease. In most of the fish, the gills on only one side were affected. Ordinarily the lesion could not be seen until the operculum was raised and the gills were exposed, but in severe cases the edge of the operculum adjacent to the gill lesion was also eroded or frayed. The characteristic bacteria invariably were seen when slides of material from the lesions were examined microscopically. No secondary invasion of saprolegnia was observed, probably because the columnaris was fatal so rapidly. The other types of lesions sometimes observed in the chinook salmon were more common in other species and will be discussed later. Regardless of the type of lesion, the affected fish drifted listlessly around the tank instead of swimming against the slight current and eventually, dead or moribund, lodged against the outlet screen.

SILVER SALMON

In May 1951, a group of silver salmon fingerlings was divided into 12 tanks receiving the three water supplies.

When this phase of the experiment was closed the following October, the mortalities of fish held in lower-intake water totaled less than one-half of 1 percent and no salmon with lesions of columnaris had been seen in these tanks.

Unlike the spring chinook salmon, silver salmon fingerlings reared in the mixed water supplies had no mortality from columnaris during the summer. The total losses from May to October were less than 1 percent in these four tanks.

In contrast to the low losses of silver salmon reared in the cooler water, the group held in upper-intake water suffered very high mortalities from columnaris, starting early in July and continuing until early in September. One tank of salmon on aerated water and one tank on unaerated water were given sulfamerazine, and one tank on each supply was held untreated as a control. Starting July 13, the treated fish were fed the drug at the 12-gram rate for 1 week and then at the 6-gram rate for 1 week. At the end of this 14-day treatment, the mortalities were much lower and the drug was discontinued. During the next week there was an increase in losses from columnaris in one tank and treatments were again administered to both tanks. Feeding of the sulfamerazine was continued for a period of 4 weeks. Then, as the mortalities had dropped to normal, the drug was discontinued. Again there was an immediate rise in mortality in one of the tanks. After a week without treatments, the fish in this one tank were fed sulfadiazine at the 6-gram rate for a 2-week period. This drug also appeared effective, as it reduced the losses from columnaris to a low level.

From May to October, the mortalities of silver salmon fingerlings reared in upper-intake water amounted to 38.4 percent and 18.4 percent in the two tanks treated with sulfa drugs and 70.0 percent and 74.1 percent in the two untreated control tanks. These results indicate that sulfamerazine, and probably sulfadiazine, will reduce mortality from columnaris in young silver salmon. It is believed that results would have been better if the treatments had been instituted earlier in the epizootic and if the drug had been administered continuously during the period of high water temperatures. It may be germane to mention at this point that, although there was no indication of any toxicity from the prolonged use of sulfa drugs in these experiments, treatments of smaller silver salmon (weighing about 2 grams each) with sulfamerazine earlier in the spring appeared to have a toxic effect and to kill some of the small salmon. Further experiments with fish of this size are planned for the future.

The typical lesions of columnaris on the silver salmon fingerlings were on the body, usually originating at the fins. Lesions at the anal fin were the most common, but attacks on the other fins were not infrequent, and some lesions originated at the snout. As the infection progressed, the number of fish with severe tail rot from columnaris greatly increased. In the typical lesion, the fin involved would become frayed and the rays would separate, and then a grayish-white area would develop on the body area at the base of the fin. This infected area, which had very distinct edges, would rapidly expand, sometimes encircling the body before the fish died. Although the skin was greatly affected, it was seldom destroyed or the musculature exposed. In some of the fish that had the most severe caudal lesions, the entire tail structure disintegrated and some tissues of the caudal peduncle were exposed. Very few

gill lesions like those common in the spring chinook salmon were observed at any time in the silver salmon.

CUTTHROAT TROUT

The fingerling cutthroat trout, which were first fed in April, were reared in the mixed water supply until July 10. At this time the fish were divided into 11 troughs receiving the three water supplies.

The fish reared in the three troughs that were supplied with lower-intake water did not contract the columnaris infection, and less than 1 percent had been lost when the experiment was terminated in October.

Columnaris lesions were frequently found on dead and moribund trout reared in the mixed water supplies, but no disease treatments were given these fish at any time. The total mortalities from July 10 to October 18 were 4.5 percent and 0.7 percent in the two troughs on unaerated water and 6.1 percent and 0.2 percent in troughs on the aerated supply. These large differences in mortalities in troughs of fish handled in a like manner are characteristic of columnaris disease, making evaluation of treatments very difficult.

In the cutthroat trout, as in the salmon, the mortalities from columnaris in fish reared in the warm upper-intake water were severe and started within a week after the fish were placed in this water supply. The two troughs on unaerated water were treated with sulfamerazine, and the two on aerated water were the untreated controls. Starting July 17, the trout were fed sulfamerazine at the 12-gram rate for 1 week and then at the 6-gram rate for 1 week. The drug at first appeared very effective and soon reduced the mortalities to normal, but the mortality in one trough again rose sharply a few days after withdrawal of the drug. Both troughs were then fed the sulfamerazine at the 6-gram rate for the next 4 weeks, and mortalities were satisfactory after 2 weeks of this treatment. This section of the experiments was terminated in September, 10 days after the drug was discontinued. At that time the total mortalities in the treated troughs were 45.5 percent and 36.9 percent; whereas in the same period losses among untreated fish in the troughs receiving the aerated upper-intake water were 82.0 percent and 42.3 percent. The sulfa treatments were of doubtful value, as one of the untreated troughs of fish had mortality similar to that in the two treated troughs. Here again it is believed that earlier and uninterrupted use of the drug might have given better results.

The most commonly observed lesion of columnaris in the cutthroat trout was on the tail and caudal peduncle, although many fish had lesions on other fins. Gill lesions in these trout were very rare. The appearance of the columnaris lesions was the same as described previously in salmon.

RAINBOW TROUT

The rainbow trout reared at the laboratory during 1951 were held in lower-intake water from first feeding in April until May 24, when they were transferred to upper-intake water. On July 6, the fish were divided into 11 groups and were placed in the three water supplies in use.

During the following 15 weeks, the trout in the single trough on aerated lower-intake water had a mortality of 4.1 percent and those in the two troughs supplied with unaerated lower-intake water had losses of 3.5 percent and 4.4 percent. There was no indication of columnaris in these fish at any time.

In this 15-week period, there were mortalities of 9.0 percent and 6.4 percent in the troughs supplied with aerated mixed water and mortalities of 11.0 percent and 6.9 percent in the two troughs of trout on unaerated mixed water. Some lesions of columnaris were seen on fish in these troughs throughout the summer, but this disease did not appear to be the cause of all the mortality and no treatments were administered.

As in all species of fish discussed previously, there was a very high mortality among rainbow trout held in the warm upper-intake water. The fish in the two troughs supplied with unaerated upper-intake water were fed sulfamerazine, starting July 17, at these rates: 12 grams daily per 100 pounds of fish for 1 week; 6 grams daily per 100 pounds of fish for 1 week; no drug for 1 week; 6 grams per 100 pounds of fish for 4 weeks. The first 2 weeks of treatments lowered the mortality, but this increased rapidly when use of the drug was discontinued for a week. The 4 weeks of continuous treatments at the 6-gram rate again lowered the losses but did not eliminate the infection. Mortalities in the untreated troughs supplied with aerated upper-intake water reached a peak late in July and then gradually returned to normal. The total mortalities from July 6 to September 13 were 16.5 percent and 22.1 percent in the troughs treated with sulfamerazine and 37.5 percent and 41.2 percent in the controls, indicating that sulfamerazine was of some value in reducing mortality from columnaris in the rainbow trout.

As with the cutthroat trout, the most common lesion of columnaris in rainbow trout was tail rot. Fish with infected dorsal fins were also seen frequently. Very few gill lesions were observed on these trout.

SUMMARY

During 1951, fingerling spring chinook salmon, silver salmon, cutthroat trout, and rainbow trout were reared in water from intakes at three levels in Dorena Reservoir.

No lesions of columnaris disease were observed in fish of any of the four species reared in water from the lower (765-foot) intake. The daily maximum temperatures of this water were 55° F. or less during most of the summer, exceeding 60° on only a few days in October.

No lesions of columnaris disease were observed in silver salmon reared in the mixed water supply. Columnaris was present in the spring chinook salmon, cutthroat trout, and rainbow trout that were reared in the mixed water supply; and these fish suffered some mortality from the disease. The maximum daily temperature of this water was near 60° F. most of the summer but exceeded 60° during a 3-week period in June.

Columnaris caused very high mortalities in all salmon and trout reared in water from the upper (805-foot) intake in the reservoir. This water supply had minimum daily temperatures above 60° F. and maximum daily temperatures above 65° from June 25 through October 2, and during much of this time the daily maximum temperature was 70° or higher.

Sulfamerazine, at the rate of 6 or 12 grams of drug daily per 100 pounds of fish, was fed for periods of several weeks to some of the salmon and trout held in upper-intake water. Treatments with this drug appeared of no value in reducing the mortality from columnaris in spring chinook salmon and were of doubtful benefit to cutthroat trout that were infected with the disease. Results were more favorable with silver salmon and rainbow trout. In most troughs or tanks, mortalities increased whenever treatments of the drug were discontinued. It is believed that more beneficial results could be obtained by means of earlier and uninterrupted treatments with sulfamerazine during periods of high water temperature.

Lesions of the columnaris infection were found most often on the gills of the spring chinook salmon, on the body at the base of one of the fins in silver salmon, and on the tails of infected cutthroat and rainbow trout. The causative bacterium, Chondrococcus columnaris, was recovered from cultures of kidney tissue of fish that had external lesions.

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A newly established brood stock of a local native strain of the cutthroat trout (Salmo clarkii) at the Creston (Montana) Station of the Fish and Wildlife Service provided a take totaling 250 million eggs in April, as reported by Blendon H. Cook, superintendent.

This brood stock has been established in order that waters within Glacier Park and northern Rocky Mountain areas may be stocked with fish that are native to those waters, rather than with trout introduced from the Yellowstone Park waters.

Whereas eggs from Yellowstone and similar sources are ordinarily taken in July, the much earlier spawning of the new brood stock will permit plantings of these trout to make much better summer growth. Furthermore, the race being propagated at the Creston Station is expected to be nonmigratory to a greater extent than the Yellowstone Park strain.

SOME PATHOLOGICAL SYMPTOMS IN BROWN TROUT ON AN ALL-MEAL DIET

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THE WRITER DESCRIBED in a previous paper (Wolf 1951) the symptoms which developed in brown trout fingerlings maintained for 26 weeks on diets consisting of dry meals without any raw meat supplement. In these diets, dried brewer's yeast and penicillin mat (constituting 19.5 percent of the dry ingredients) were the sources of B vitamin.

On these diets (yeast and mat), definite pathological symptoms developed in about the same proportion of trout. These symptoms consisted of an abnormally light coloration and a progressive loss of balance--a condition in which fish swam in a contorted, S-shaped position as though undergoing a muscular spasm. Counts of red blood cells indicated no anemia in even the worst specimens.

Although at the end of 26 weeks the mortality was not high, the above-described condition was steadily becoming more pronounced. It was therefore decided to terminate the yeast-versus-mat experiment while the fish could still be used in tests to determine the cause of the condition, that is, while the fish were still able to consume food.

PROCEDURE

Six lots were available for these tests. Lots 1 and 2 had received yeast, and lots 3 and 4 had received penicillin mat, but all other diet ingredients for these lots had been the same. A fifth lot consisted of fish that had been removed from these four lots during the original experiment to prevent overcrowding, and had been given yeast since the time of removal from the original lots. This lot was not included in the original experiment and was not mentioned in the previous paper. These fish had developed the same symptoms as the fish in lots 1 through 4. Lot 6 was the check group, maintained on a diet of raw beef spleen and pork spleen. No pathological symptoms appeared at any time in this group. There were 95 fish in each lot.

It was first suspected that the condition of the fish might be caused by gossypol poisoning from the cottonseed meal. This suspicion was increased by the fact that McCay and Tunison (1934) reported similar symptoms in brook trout which were fed for 44 weeks on a diet which contained one-third cottonseed meal.

The diet schedule shown in table 1 was instituted. It will be seen that, in comparison with the previous diets (Wolf 1951), the proportion of cottonseed meal and soybean meal was somewhat increased at the expense of the fish meal and skim milk. This was done in order to augment any possible injury caused by the cottonseed meal. If gossypol poisoning was the cause of the trouble, lots 1 and 2 should have become worse, lots 3 and 4 should have improved because they received no cottonseed meal, and lot 5 should have improved because autoclaving the cottonseed meal would destroy any gossypol present.

It was decided to introduce another variable rather than to continue lots 1 and 2, and lots 3 and 4, in duplicate. Selection of the second variable was influenced by the consideration that the symptoms of these fish faintly resembled those found where diets lacked sufficient vitamin B_1 (Wolf 1942).

Throughout the experiment the fish were fed all they would eat once daily, six times a week. The new diets were begun on the day the last weighings reported in the previous paper (Wolf 1951) were made. The diets were continued for 6 weeks. The increases in the cube root of the average weight of the fish, measured at 2-week intervals during the first 6 weeks, are given in the first section of table 2. As shown in this table (which should be compared with the data for the same lots in table 2 of the previous paper), all the lots made an unaccountably poor growth during

TABLE 1.--Composition of diets, in grams and milliliters, during first 6 weeks

Ingredient	Lot number				
	1	2	3	4	5
Cottonseed meal	30	30	0	0	1/30
Soybean meal	0	0	30	30	0
Dry skim milk	5	5	5	5	5
Fish meal	7	7	7	7	7
Brewer's yeast	16	16	16	16	16
Gelatin	4	4	4	4	4
Oatmeal flour	12	12	12	12	12
Lard	4	4	4	4	4
Cod-liver oil	2	2	2	2	2
Salt	2	2	2	2	2
Water	115	115	115	115	115
Vitamin B_1	0	(2/)	(2/)	0	0

1/ Autoclaved. 15 pounds, 20 minutes.

2/ Pure crystalline vitamin B_1 (thiamin hydrochloride) was added to this diet each day immediately before feeding, at the rate of 10 milligrams per 100 grams of food.

the first 2-week period, although lots 1, 4, and 5 were much worse than lots 2 and 3, which received the vitamin B_1. Growth improved during the next 4 weeks but at the end of the sixth week was still better in lots 2 and 3. Pathological symptoms did not change during the 6 weeks: at the end, all five lots looked about the same as they had at the beginning of the test--no better and no worse. Mortalities were confined to lot 2, which lost three fish.

Results at this point indicated that the abnormal condition of the fish could not have been caused by the cottonseed meal, as lots 1 and 2 had not deteriorated and lots 3, 4, and 5 had not improved. Also, it did not appear that an insufficiency of vitamin B_1 had caused the symptoms, although the added vitamin had definitely increased the appetite and improved the rate of growth of lots 2 and 3.

Because the experiment did not appear to be leading to disclosure of the cause of the failure of the trout, it was decided to cease the tests of cottonseed meal and vitamin B_1 and to begin a test of vitamin B_{12}. All the diets were therefore changed to include equal amounts of cottonseed meal and soybean meal. Lot 5 was dropped from the experiment. Lot 6 was continued on beef and pork spleen. Lots 1 through 4 were given a supplement of vitamin B_{12}. To the diet of lot 1, for each 197 grams of the complete feed, was added 10 micrograms of B_{12}; to the diet of lot 2, 20 micrograms; to the diet of lot 3, 40 micrograms; and to the diet of lot 4, 60 micrograms.

It will be seen in table 2 that the growth rate diminished in all four lots during the last 8 weeks, but much more rapidly in lots 1 and 4 than in lots 2 and 3. At the end of the last week, the fish in lots 2 and 3 were still eating fairly well, whereas those in lots 1 and 4 had ceased to eat. At this time the lots also differed strikingly in appearance. Lots 1 and 4 contained fish which had a permanent kink or S-shape when viewed from above. The fish were very listless. Many lost their balance intermittently. There was also a peculiar thickened or blistered condition of the operculae in a few fish, especially in lot 1. This lot appeared a little worse than lot 4. In lots 2 and 3, no fish had the bent condition, either permanently or intermittently. There was no noticeable difference between lots 2 and 3. There were no longer any light-colored fish in any of the groups. Mortality during the 8 weeks of the B_{12} test was still low, consisting of one to three fish in each of the four lots. No deaths occurred in lot 6.

Because of construction work at the Rome hatchery, the experiment had to be terminated. Although the complete cause of the decline of the fish had not been discovered, some information relative to vitamin B_1 had been brought to light.

DISCUSSION

The much better performance of lots 2 and 3, as compared with that of lots 1 and 4, during the final 8 weeks of observation seems more likely to be an aftermath of the previous 6-week supplementation with vitamin B_1 than a result of the B_{12} feeding. If vitamin B_{12} were regarded as responsible, it would have to be accepted that too much B_{12} (lot 4) induced the identical symptoms as too little (lot 1). This would be rather difficult to believe. The B_{12} apparently corrected the light-colored condition which was so striking in many of the fish earlier in the experiment. The significance of this light coloration is not known.

As the fish in lots 2 and 3 were showing a diminishing rate of growth at the end, it is obvious that the diet was still deficient in some essential quality. It appears, however, that much of the trouble which occurred in the trout with the original meal diets was caused by a lack of vitamin B_1.

This raises the question of whether the yeast was deficient in B_1, or whether the B_1 present was largely unavailable to the trout, or whether it was destroyed by other ingredients of the diet.

According to the published figures for brewer's yeast, the original diets should not have been deficient in vitamin B_1. The 16 grams of dried yeast contained in the 197 grams of ready-to-feed diet mixture should

TABLE 2.--Weekly increase in cube root of weight, by 2-week periods[1/]

Lot No.	Diet variable	2-week periods			Diet variable	2-week periods			
		1st	2d	3d		4th	5th	6th	7th
1	Cottonseed meal	1.5	29.5	56.5	B_{12} (10 mcg.)	42.5	31.5	19.0	[illegible]
2	Cottonseed meal, B_1	22.0	57.0	71.5	B_{12} (20 mcg.)	49.0	49.0	40.5	39.0
3	Soybean meal, B_1	18.0	59.0	65.0	B_{12} (40 mcg.)	53.0	38.5	35.0	23.5
4	Soybean meal	3.5	51.0	55.5	B_{12} (60 mcg.)	32.5	21.0	5.5	0
5	Cottonseed meal (heated)	4.0	55.5	30.5					
6	Meat	45.5	55.0	68.0		61.0	41.0	50.5	45.0

[1/] The increase in the cube root of the weight has been multiplied by 1,000 to eliminate decimals.

have provided three times the amount of B_1 contained in 197 grams of beef liver (based on average figures in the literature). A diet of straight beef liver certainly provides more vitamin B_1 than trout need; for even on a diet of spleen (which contains much less B_1 than is found in liver), trout did not develop a vitamin B_1 deficiency.

No analyses of the diets were made; so it is possible that the particular yeast used in these diets was extremely low in vitamin B_1. This, however, seems highly improbable. It seems more likely that the thiamin in the yeast was either unavailable to trout or was destroyed by other constituents of the diet mixture. The latter possibility is not ruled out by the fact that the addition of pure thiamin hydrochloride to the diets aided the fish. As stated previously, the pure thiamin was always stirred into the feed mixture immediately before feeding.

SUMMARY

Brown trout were maintained for 40 weeks on dry-meal diets. By the end of 26 weeks, though growth and mortality were still normal, striking pathological symptoms had developed.

Changes made in the diets over a period of 14 weeks established the following points:

1. The symptoms were not caused by gossypol in the cottonseed meal.

2. The symptoms were not caused by lack of vitamin B_{12} in the diets, although the addition of B_{12} eliminated an unnatural light coloration in the fish.

3. Addition of crystalline vitamin B_1 in the form of thiamin hydrochloride greatly benefited the trout, although the basal diets contained a large proportion of dried brewer's yeast.

4. The vitamin B_1 may have been the only critical vitamin, and continued supplementation with thiamin hydrochloride might have made the meal diet satisfactory for an indefinite period.

ACKNOWLEDGMENT

The vitamin B_{12} used in this experiment was donated by Lederle Laboratories, Pearl River, New York.

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Sea lampreys did not enter Lake Superior until 1947, and all those that appeared in Lake Superior prior to 1952 came from Lakes Huron and Michigan. In 1952, for the first time, Lake Superior is expected to produce millions of these parasites in its own streams. Control of the sea lamprey is the more important as a rather large population of lake trout still remains in this lake.

EFFECTS OF INJECTED PITUITARY MATERIAL UPON THE SPAWNING OF BLUEBACK SALMON

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AN EXPERIMENT was conducted in the summer and fall of 1951 at the Salmon-Cultural Laboratory of the Fish and Wildlife Service at Entiat, Washington, to determine whether injections with gonadotropic material would accelerate the maturation time of blueback salmon (Oncorhynchus nerka).

The blueback salmon and certain races of chinook salmon (O. tschawytscha) undergo a prolonged period of maturation between the upstream migration and the actual spawning. Artificial propagation techniques often require that the fish be diverted during the upstream migration and be confined until fully matured. During this holding period trauma and disease frequently cause heavy losses in debilitated fish, often just as the fish have reached maturity. If the retention period could be shortened, the number of fish reaching maturity could probably be increased and the egg take enlarged. A shortened holding period could also produce healthier fish for spawning, with a consequent improvement in egg quality.

Von Ihering (1937) and Hasler (Hasler et al. 1940) have reported successful use of injected pituitary material to force the elimination of sex products of mature fresh-water fish that were held under unfavorable conditions. Hasler has also reported (Hasler et al. 1939) an acceleration of maturation in trout by injections with pituitary extract.

PROCEDURE

The experiment at Entiat began August 2, 1951, when the adult fish that had received injections of pituitary material were placed in rearing ponds for observation and spawn-taking. The experiment was terminated on January 31, 1952, when all of the remaining fingerlings were transferred to the fish-cultural station at Leavenworth, Washington, for rearing.

Pituitary glands of chinook salmon were collected at the Columbia River Packers Association Cannery at Astoria, Oregon, from July 13 to July 18, 1951. The glands, taken from fish dead 8 hours to 3 days, were not segregated according to the sex of the fish. Upon removal, the glands were dropped into dry-ice-chilled acetone, where they remained for 3 hours. The used acetone was then replaced with fresh chilled acetone. At the end of 48 hours, the glands were removed from the acetone, dried on filter paper, and stored in brown glass bottles.

The dried pituitary glands were reduced to a fine powder in a glass mortar and, 24 hours prior to use, were mixed into distilled water made slightly alkaline (pH 7.6) by the addition of sodium bicarbonate. The concentration was approximately 2 percent, or 2 grams of pituitary gland to 100 milliliters of water. Sufficient solution was prepared for 100 injections of 2 milliliters each (roughly equivalent to the glands from four chinook salmon) and 100 injections of 4 milliliters each (the equivalent of eight glands). The suspended material was fine enough to pass through a No. 22 hypodermic needle. As it was suspected that the glands might not have been active because they were collected at such an extended length of time after death, the dosage used was twice the amount recommended by Dr. O. H. Robertson (personal communication).

Migrating adult blueback salmon were captured in the fishway at Rock Island Dam and hauled in a fish-distribution truck to the Entiat Station. This sample unavoidably contained a large number of bruised fish because of emergency brailing over McNary Dam. The fish were taken at random from the truck and placed, in rotation, in three 130-foot Foster-Lucas ponds. The design of the experiment called for 100 fish in each pond; but because 2 of the 300 fish were jack chinook salmon, it was necessary to stock each pond with only 99.

The fish in pond No. 1 were given no injection, the fish in pond No. 2 were injected with 2 milliliters of the preparation, and those held in pond No. 3 were injected with 4 milliliters of the preparation. By recommendation of Dr. Robertson (personal communication), injections were made into the back muscles, as done by Von Ihering (1937). The needles were inserted--about half an inch to the side opposite the posterior point of insertion of the dorsal fin--and were driven anteriorly parallel to the fin on a ventral diagonal for the full 1½ inches of their length before injections were made. During and after the injections, the flesh of the fish was massaged in an anterior direction in order to diffuse the fluid into the muscle.

Each fish treated was held by one person; the injection was made by a second person. One team of two men handled fish for the 2-milliliter injections, placing these fish in pond No. 2. Another team handled fish for the 4-milliliter injections, placing these fish in pond No. 3. A fifth man placed a fish in pond No. 1 (the control) each time the teams placed a fish in the other two ponds. Thus a random distribution of the fish was assured.

Each day the ponds were observed for sick or dead fish and for signs of color changes. Dead fish were autopsied, and the information was recorded. In spite of the very poor condition of the fish, holding in the Foster-Lucas ponds was successful and the mortalities were not excessive--probably because the average daily pond temperatures did not exceed 60° F. Only one fish showed evidence of injury which could be attributed to the injection. All others appeared to have died from bruises and injuries and general debility ascribable to migration.

Pond No. 3 was seined at intervals until ripe males were found; then all ponds were checked and the females were examined daily for evidence of maturity. Ripe females were held overnight and spawned the next day, a general practice at this station. After spawning was completed, the remaining males were killed and autopsied.

The eggs were held until they hatched. Mortalities were recorded as they occurred. The fry, put in troughs, were held until they were feeding so that the defective fry could be removed.

RESULTS

Early autopsies revealed that the degree of maturity for both sexes was not far advanced. These autopsies and the checks made on live fish for ripeness bore out the assumption that the sample was suitably green at the beginning of the experiment.

After the injections a more rapid change in coloration took place. By the twelfth day, differences were apparent between the fish which had been injected and those which had not. No difference between fish in pond No. 2 and fish in pond No. 3 could be detected.

On the twenty-first day, two visiting biologists who were unfamiliar with the experiment could see a difference between the injected and the uninjected fish. Two days later, a fisheries technician made a similar observation and, moreover, detected a difference between fish in pond No. 2 and those in pond No. 3. This man stated that the coloration of the females in pond No. 3 indicated that they were nearing spawning.

The increased rate of color change in the injected fish was the only positive result of the injections. The doubled amount of the injection given fish in pond No. 3 did not result in a proportionately greater or faster color change.

The first ripe fish, males, were handled on the thirty-fourth day. No females ripened until the forty-first day, when two were found in each pond. Half of the females in ponds No. 1 and No. 3 had spawned by the midpoint of the spawning period; half of the females in pond No. 2 had spawned only 3 days earlier. Throughout the spawning period, the number spawned from each pond varied only slightly.

Spawning was completed in ponds No. 1 and No. 2 on the sixty-third day and in pond No. 3 on the sixty-fourth day. Although one female each remained in ponds Nos. 2 and 3, the one in pond No. 2 died, still green, on the last spawning day and the one in pond No. 3 died, almost ripe, on the sixty-eighth day. At this time several males remained in each pond.

It is very significant that females matured in each pond on the same date in spite of the fact that the rate of coloration had been different. This simultaneous ripening was apparent throughout the period of spawning, making it impossible to show a difference due to the injection.

The average numbers of eggs per female for the three ponds indicated that the injected material did not influence the quantity of eggs. Also, when tested by analysis of variance (Snedecor 1946), no correlation could be found between the average size of the eggs and the amount of the injection. These data are summarized in table 1.

In order to evaluate any effect of the pituitary injections upon fertility and development, the eggs were retained and hatched

TABLE 1.--Numbers of blueback salmon, mortalities, and eggs

	Pond No. 1 (Control)	Pond No. 2 (2-cc injection)	Pond No. 3 (4-cc injection)
Total number of fish at start	99	99	99
Number of males at start	66	59	56
Male mortality prior to spawning	8	11	10
Number of females at start	33	40	43
Total female mortality	13	15	14
Number of females spawned	20	25	25
Number of defective females (defective eggs)	0	0	4
Spawning period	9/12 - 10/3	9/12 - 10/3	9/12 - 10/4
Total number of eggs taken	57,825	78,443	70,460
Average number of eggs per female	2,891	3,017	2,818
Average number of eggs per ounce	324	337	347

and the fry were carried past the swim-up stage. (See table 2.)

As hatching progressed, it was apparent that many of the fry were defective. These defective fry were found in all three lots but were noticeably fewer in the lot from pond No. 3. Percentage mortalities, based on the number of eggs that hatched, showed a much greater loss for lots from pond No. 1 and pond No. 2. Losses were taken through January 31, at which date sufficient time had passed to allow the mortalities to drop to a somewhat normal or even level. The over-all mortality reflected the losses of the green-egg stage, and the percentage total mortality was greatest in the lots from ponds No. 2 and No. 3.

The very heavy mortality among the green eggs from the two lots of injected females indicated that a decidedly lower fertility was caused by the injection. The 41.4 percent loss for the lot from pond No. 3, as compared with the 30.8 percent loss for the lot from pond No. 2, demonstrated that the increased dosage further lowered the fertility.

Losses in the eyed-egg stage were comparatively low and so nearly alike that no discussion is warranted. The heavy losses in the fry from the control lot and from the lot that received the 2-milliliter injection may represent a biological variation due to the stock itself. Fry with mottled yolk sacs, pinched tails, bent backs, and other deformities were found in all lots, though most frequently in the lots from pond No. 1 and pond No. 2. As one defective lot was the control and the other an injected lot, this probably had no relation to the injections.

TABLE 2.--Mortalities during egg and fry stages

	Pond No. 1	Pond No. 2	Pond No. 3
Number eggs taken	57,825	78,443	70,460
Green egg mortality	4,680	24,179	29,194
Eyed egg mortality	2,421	3,903	2,726
Fry mortality	9,950	11,996	3,206
Total mortality	17,051	40,078	35,126
Percentage green-egg loss	8.1	30.8	41.4
Percentage eyed-egg loss	4.6	7.2	6.6
Percentage fry loss	19.6	23.8	8.3
Percentage total mortality	29.5	51.1	49.9

SUMMARY

The results which followed the injections of pituitary gland material in the present test were: a noticeable increase in spawning colors, no change in rate of maturation, and lowered fertility. The intensified colors of the fish were directly correlated with the injections, though apparently not with the amount of material used. No differences in maturation were produced by the injected material. The absence of an accelerated spawning may have been the result of a loss of gonadotropic hormones during the time that elapsed between the death of the fish and the collection of the glands.

A detrimental effect of the pituitary injections was shown in the quality of the eggs. Four of the females had visibly defective eggs that were discarded at once. Eggs from injected females had lower viability than eggs from control females. This upset may well have been the result of not segregating the glands according to the sex of the fish.

Plans have been made for further tests that will take into account the results obtained to date. Pituitary glands have been collected from spawning chum salmon (O. keta) that had been segregated according to sex, and the two types of glands have been kept in separate containers. Collections have been made promptly so as to eliminate any loss of potency after death of the fish. Injections with the preparation from each type of glands will be made on separate lots of fish to test any reaction due to difference in sex.

ACKNOWLEDGMENTS

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The authors wish to acknowledge also the advice and offers of assistance which were received from Dr. A. D. Hasler and his assistant Mr. Wisby of the University of Wisconsin and from Dr. G. F. Weisel of Montana State University. Acknowledgment is made to the management of the Columbia River Packers Association Cannery, Astoria, Oregon, and to Mr. Russel Sinnhuber of the Astoria Seafoods Laboratory for facilities and courtesies extended.

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AN EGG WASHER

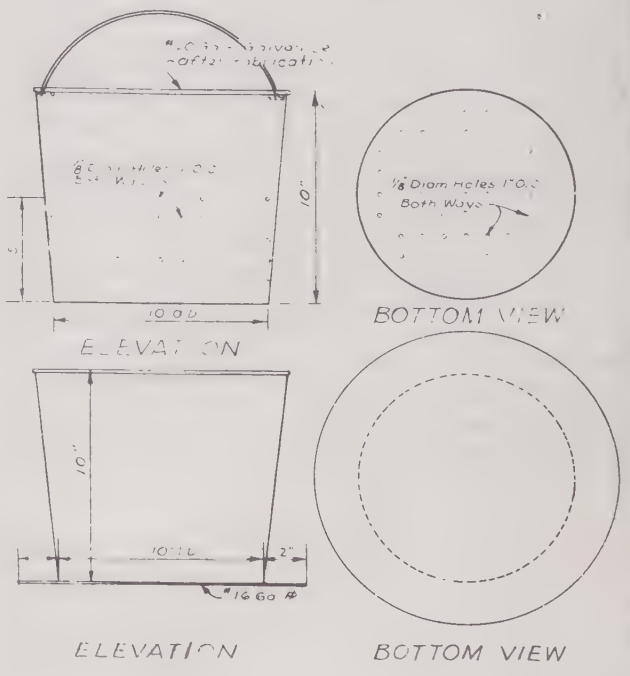
A DEVICE FOR WASHING salmon and trout eggs during spawn-taking operations has been recommended by Lewis R. Garlick, regional supervisor of fish culture at the Portland Regional Office of the Fish and Wildlife Service.

The spawning receptacle, into which the fish are stripped of their eggs and milt in the usual manner, consists of an ordinary galvanized-iron bucket containing a perforated metal liner constructed to fit snugly into the bucket. To facilitate the removal of the liner from the bucket after the eggs have been fertilized, the liner is equipped with a brail and the bucket has a bottom flange (see drawing) upon which the operator can stand.

When the eggs have been fertilized and are ready for washing to remove excess milt and body fluids, the liner is extracted from the bucket and immersed in clean flowing water to within approximately an inch from the top. After a suitable period of washing, the liner is removed from the water and the eggs are permitted to drain. Then the eggs are poured from the liner into a container for transport to the hatchery.

It should be pointed out that the size and position of the holes as shown in the accompanying drawing were satisfactory for use in washing chum salmon eggs. When larger or smaller eggs are to be washed, it may be necessary to alter the position and size of the perforations.

It has been found that serious mortality occurs if the eggs are not washed immediately after being taken. Where several million eggs are taken daily in connection with salmon and trout spawning, the washing takes a significant amount of time--and therefore of manpower. This device is expected to effect a considerable saving of both.



THE EFFECT OF TROUT STOCKING ON THE RATE OF CATCH

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DURING THE 1950 TROUT FISHING SEASON, an effort was made to gather data that would indicate more closely the extent of the fishing success on the streams in the various Cooperative Wildlife Management Areas in western North Carolina.

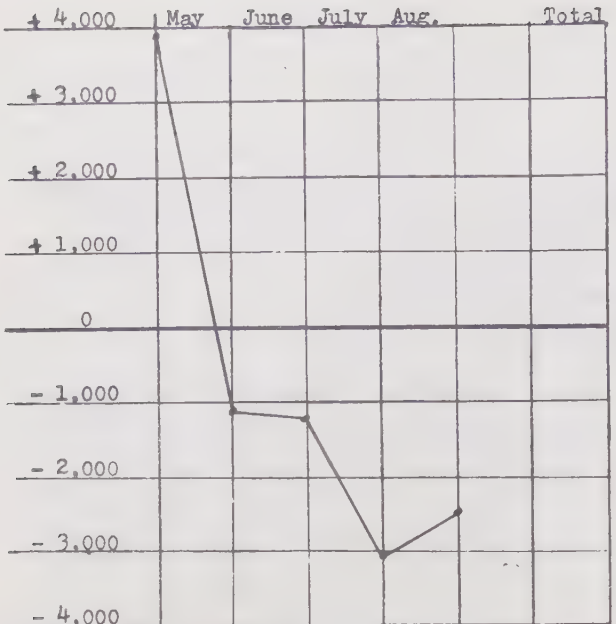
In years past, most of the data collected were used to make the annual creel report, which tended to be a record of the relationship between the numbers of fish stocked and the numbers caught. Stocking practices were altered very little from year to year. The individual streams were stocked periodically, and the creel reports indicated that an approximately equivalent number of fish was caught somewhere in the area. The streams that produced better than others were not really known.

It is known that there is a difference in the productivity of fish food and of fish in the various streams, and that many fish may migrate to better adapted waters. The extent of the productivity or migration cannot be determined from a total creel report for an entire area. A creel report of the situations on the individual streams would seem necessary. To make an intensive investigation which would supply exact information on an individual stream basis, much money and labor would be necessary. However, a relative report made by the individual fishermen is a good indication of what might be occurring on the streams, and on this basis the 1950 trout creel-census surveys were conducted.

In attempting to make a report of the individual streams, a part of the information was asked of the fishermen. Stocking was done as it had been in the past. The streams were stocked prior to the opening date and at intervals thereafter when it was believed necessary. The individual creels were recorded by species, numbers, and weight as the fishermen left the area. The fishermen were asked in what particular stream the fish were caught, and how long they had fished. This information gave the catch information for the individual streams, as well as the fishing intensity on the streams. From these reports, the catch per man hour of effort was computed. It is believed that the figures presented include a minimum of error, since they are totals and are not based on samples. All fishermen pass through the checking stations when entering and leaving the areas.

To get a picture of the fishing by monthly intervals, graphs were made for three of the management areas. These graphs indicate depletion of the trout population in each area as it occurred. The average catch per man, the number of fishermen each month, and the catch per man hour of effort are recorded to show the relationships as they occurred. A zero axis is placed to show the point below which the depletion of the normal population occurs. Since the graphed points show the difference between the numbers stocked and the numbers caught, any point below the zero axis must indicate that depletion is from the normal population of the streams. Catches will consist of both stocked fish and fish from the native population of the streams, but for a better understanding of the graphs it should be assumed that the depletion below the zero axis is from the native population. The number of stocked fish that can be taken by hook-and-line fishing has been found to be about 70 percent as a maximum. Therefore, the depletion of the normal population is undoubtedly greater than the graphs indicate.

In the Mount Mitchell Cooperative Wildlife Management Area, the South Toe River and its tributaries comprise approximately 37 miles of trout waters. Figure 1 shows that 3,900 trout were stocked prior to the opening of the fishing season. During the first month of fishing, 5,037 trout were removed from the streams, resulting in a depletion of the native population of 1,137 trout even if a 100-percent catch of stocked trout is assumed. The fishing pressure was very heavy. The 1,519 fisherman trips resulted in an average catch of 3.3 fish at the rate of 0.76 fish



	May	June	July	Aug.		Total
Fishermen	1519	543	521	258		2841
C. P. M. H.	.76	.73	.69	1.1		.77
Av. Catch	3.3	4.0	4.0	5.2		3.74
Total Catch	5037	2184	2084	1347		10652
Total Stock	3900	2135	250	1950		8235
Difference	1137	49	1830	603		2417

FIGURE 1.--Mount Mitchell Area: South Toe River and tributaries.

per man hour of effort. During the next month there was about a two-thirds reduction in fishing pressure. Only 543 men fished the streams for an average catch of 4.0 fish and a slightly lower (0.73) catch per man hour of effort. During this month the stocking was about equal to the catch and little actual depletion occurred. During the third month the number of men who fished was approximately the same as during the previous month. Stocking was slight, but the catches held at 4.0 per man average. Fish were somewhat harder to take, as the catch per man hour of effort (0.69) indicates. The depletion of trout on the area was greatest during this month. By the end of this month, the catch included 3,000 more trout than had been stocked. In the last month of fishing, the number of fishermen was reduced to about 50 percent of the numbers in the two preceding months. Only 258 men fished, showing an increased average catch of 5.2 fish or an increased return of 1.1 fish per man hour of effort.

A glance at figure 1 and the assumed zero axis shows that the stocked fish theoretically carried most of the fishing during the first month, when the fishing pressure was greatest. After the first month, the graphed points

TABLE 1.--Catch and stock report by streams in the Mount Mitchell Area

Stream	Catch	Stock	Men	Average catch	Catch per man hour
South Toe River	4,311	2,050	1,239	3.50	0.68
Neal Creek	579	450	221	2.60	.55
Hemphill Creek	174	550	23	7.60	1.00
Lower Creek	248	350	45	5.50	1.10
Upper Creek	500	700	84	6.00	1.00
Rock Creek	627	388	115	5.50	.71
Middle Creek	85	100	13	6.50	1.10
Lost Cove Creek	102	-	23	4.40	.93
North Fork Creek	-	150	-	-	-
Left Fork Creek	-	150	-	-	-
Curtis Creek	2,186	1,500	544	4.20	.95
Newberry Creek	1,261	1,100	320	3.90	.86
Mackey Creek	578	750	214	2.70	.97
Total	10,652	8,235	2,841	3.74	.77

remain below the native population line (or zero axis) for the remainder of the fishing season, even though stockings were made to minimize the depletion. At one time in July about 3,000 trout in addition to those stocked had been taken from the streams. Were it assumed that a maximum of 70 percent of the stocked fish were caught, further depletion of the normal population would be indicated. As 8,235 trout were stocked and an estimated 30 percent were not caught, the native population must have compensated for 2,471 of the stocked trout. Adding this figure to the indicated depletion of 3,000 native trout, we arrive at a total catch of at least 5,500 trout from the native population.

The return per unit of effort is the recognized basis for determining the quality of fishing. The figures just noted are of particular significance when it is observed that the catch per man hour increased from 0.76 fish during the first month to 1.1 fish during the last month in spite of the fact that the streams were carrying nearly 7,000 fewer fish. It may be further observed that the 1,519 fishermen of the first month were reduced by five-sixths (to 258) during the last month. It appears that the catch rate is much more greatly affected by the number of fishermen on the stream than by the number of fish in the stream.

Table 1 is the catch and stock record for the individual streams of the Mount Mitchell Area. The catch record was given by the fishermen as their creels were checked. The stocking record was made by the hatchery personnel.

Those streams with the least fishing intensity had the better catch records. The

time required to catch fish on these streams was less than on the larger and more easily fished streams, where there were more fishermen. Some migration may have occurred, but it seemed not to injure the fishing on the small streams. It is noteworthy that in the South Toe River the catch exceeded the stocking by more than 100 percent, yet the catch per man hour remained as high as 0.68. This is to be contrasted with streams such as Hemphill Creek, Lower Creek, and Upper Creek, where the total catch was less than the number of stocked fish. Here the highest average catch per man hour was 1.1 fish. It appears, then, that an average catch of 1.1 fish per man hour by all fishermen and under all circumstances is the best that can be obtained in these streams--even by excessive stocking.

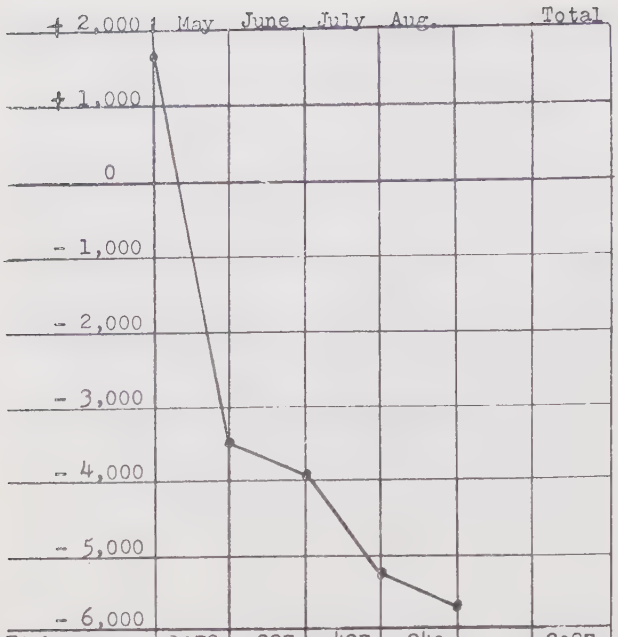
Further, Lost Cove Creek, which received no stocking, had a catch per man hour of 0.93 fish. Admittedly, the population of this stream may have been affected by migration from other heavily stocked streams of the area, but this rate of catch for an unstocked stream is not inconsistent with the records from the North Fork of the French Broad. The North Fork of the French Broad is a small, remote stream visited by less than 100 men per month. It was not stocked with hatchery fish, yet it produced more than 2,000 fish from its native population for an average creel of 5.4 fish. The catch in this fine stream was exceeded only on the Santeetlah Area. This shows again that the catch depends less on stocking than on the numbers of fishermen.

The records of the Mount Mitchell Area, then, might be summarized by saying that excessive stocking produced a return of 1.1 fish per man hour of effort; a native population without stocking but subjected to relatively light fishing pressure maintained an average catch per man hour of 0.93 fish; and extreme depletion under very heavy pressure, where the catch was more than 100 percent greater than the stocking, produced a drop in the average catch per man hour to only 0.68 fish. Thus, the difference in the rate of return between situations of excessive stocking and extreme depletion was a maximum of 38 percent. This brings up a legitimate question as to whether the practice of indiscriminate stocking of trout streams has a commensurate value in relation to the cost, or whether the value of trout stream stocking is largely psychological so far as the fishermen are concerned.

The West Fork of Pigeon River within the Sherwood Refuge consists of three lesser forks which might possibly contain 25 miles of trout water. The Left Fork is the richest of the three, Middle Fork is second, and Right Fork is almost barren of bottom food (Chamberlain 1943). The area streams were stocked with 1,612 trout before the opening of the fishing season. During the first month of fishing 5,072 trout were removed by 1,073 men for an average catch of 5.1 fish at the rate of 1.08 fish per hour of effort. A depletion of 3,460 trout from the native population materialized during the first month. In June only 337 men fished, taking an average catch of 5.3 fish per man and a catch per man hour average of 0.97 fish. The depletion totaled 3,935 trout at the end of June. In July the fishing pressure increased by about 100 men and the average rate of catch dropped to 0.92 fish per man hour of effort. The total depletion at the end of July was 5,221 trout. In August 240 men fished the area. This was about one-fifth the number of fishermen on the streams during the first month. The average catch increased to 4.9 fish per man, and the catch per man hour increased to 1.0 fish. The total depletion at the end of the season was at least 5,650 native trout in addition to the 4,279 stocked trout, even if it is considered that 100 percent of the stocked fish were taken during the season. (See figure 2.)

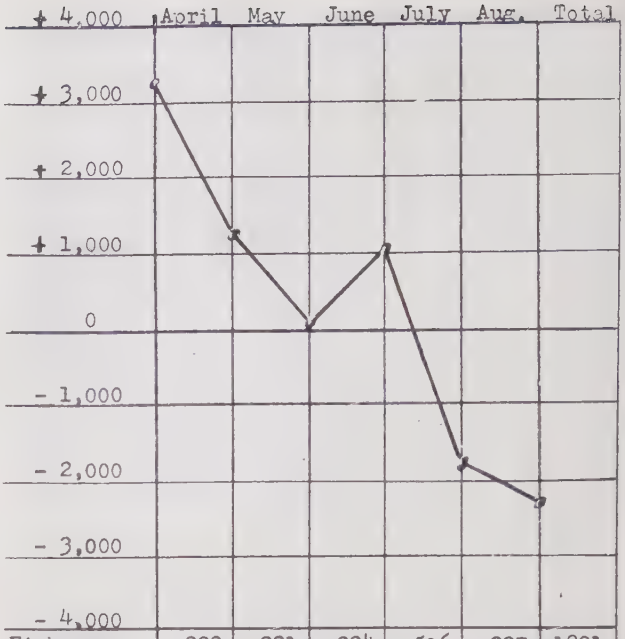
At this point it might be well to compare the population curves for the Mount Mitchell and Sherwood Areas, as they are extremely similar in most respects. The stocked fish carried the fishing load only during part of the first month. Both areas were subjected to extremely heavy fishing pressure during the first month and to only about one-third as much during the two succeeding months. In the fourth month of the season the fishing pressure was reduced to 20 percent or less of that at the beginning of the season. This greatly decreased fishing pressure presumably accounted for the increased catch rate at the end of the season, even though the fish populations at the time were very greatly reduced. It might reasonably be observed from the Mount Mitchell Area records that the increased catch rate in August was the result of an excessive stocking during that month. However, this thought is refuted by the records from the Sherwood Area, in which the catch rate increased during August under very light fishing pressure, even though the total population of the stream continued to diminish. This indicates that the lack of fishing pressure, rather than the stream population, has the greater effect on the catch rate.

There are about 40 miles of water in the Santeetlah Cooperative Wildlife Management



	May	June	July	Aug.		Total
Fishermen	1073	337	437	240		2087
C. P. M. H.	1.08	.97	.92	1.0		.99
Av. Catch	5.1	5.3	4.7	4.9		4.76
Total Catch	5072	1771	1887	1199		9929
Total Stock	1612	1297	600	770		4279
Difference	3460	474	1287	429		5650

FIGURE 2.--Sherwood Area: West Fork of Pigeon River.



	April	May	June	July	Aug.	Total
Fishermen	333	331	324	506	397	1891
C. P. M. H.	1.3	1.3	1.7	1.5	1.3	1.4
Av. Catch	6.1	6.9	6.6	5.5	5.3	6.0
Total Catch	2020	2290	2134	2776	2096	11316
Total Stock	3300	1200	3000	0	1600	9100
Difference	1280	1090	866	2776	496	2216

FIGURE 3.--Santeetlah Area, Station 1: Big Santeetlah and Little Santeetlah.

Area, Station 1. Figure 3 shows that 3,300 trout were stocked before the opening date. Data from this area are presented for contrast with the two previous areas, as the fishing pressure here was very even throughout the season. Under constant and rather light fishing pressure, the catch rate remained constant at 1.3 fish per man hour during the first 2 months. In June an unusually heavy stocking was made in anticipation of heavy holiday fishing pressure. The catch rate increased to 1.7 fish per man hour in June, dropped to 1.5 fish in July, and returned to the original 1.3 fish in August (when the trout population numbered 5½ thousand below its opening-day level).

There are several significant factors to be observed from the data and the population curve for this area. More than 11,000 fish were caught. The fishing pressure was relatively light, and the catch rate was high. Fishing pressure was exceptionally constant throughout the season, and so was the catch rate. Even if it is assumed that all stocked fish were caught from the beginning of the season to the end, the trout population had a net depletion of more than 5½ thousand fish. The catch per man hour was exactly the same in the last month of the season as in the first. Since the catch rate was entirely unaffected by the decreased population, we must conclude that the number of fish in the stream was not a limiting factor on fishing success. Reasonably, we must further conclude that at least some part of the stocking was excess to maximum fishing success and consequently was wasted.

CONCLUSIONS

There are many factors, besides the number of fish present in the streams, that affect the "catchability" of trout. The differences in the ability of fishermen are averaged out by using the results obtained by a large number of fishermen--and consequently finding an "average fisherman." Other variables are not so easily controlled. Climatic conditions affect the tendency of fish to feed. The difference between April temperatures and August temperatures probably affects catchability. Certainly rainfall, or lack of it, producing high or low water stages in the streams, affects fishing results. Water levels are lower in August than in May. Large numbers of fishermen tramping beside or in

a stream tend to reduce the catchability of trout by frightening them. In spite of these variables, several important conclusions are indicated by the data.

1. Creel reports for an entire area or watershed may be misleading if applied to any one stream. Management should be on a basis of individual stream records.

2. The catch per man hour of effort is a better criterion for evaluating the quality of fishing than the average catch, because fishermen tend to fish longer per fishing trip in June.

3. The smaller streams are neglected for the larger and more easily fished ones, yet the fishing results are often better in the smaller streams where there are fewer fishermen.

4. In water which produces a native trout population, heavy stocking before the opening of the season need not be considered essential for a good catch return if the fishing intensity is not excessive.

5. The normal population of trout producing waters usually supports a large part of the total catch.

6. In a stream carrying a normal trout population, the addition of fish has relatively little effect on the rate of catch. Apparently, other limiting factors apply. Streams seem to have a more or less definite maximum return per unit of effort, and this cannot be increased to any appreciable extent by increasing the number of fish present.

7. Fishing intensity, when heavy, will tend to lower the catch rate, presumably because of the disturbance made by the fishermen in the trout habitat.

8. The accepted aim of trout stream management is to provide the shortest time between bites. It appears that management plans must include, as a primary objective, some effort to distribute the fishing pressure as thinly as possible over all the available waters and over the whole fishing season. The data presented support the belief that this factor is more important in fishing success than is heavy stocking that results in high populations.

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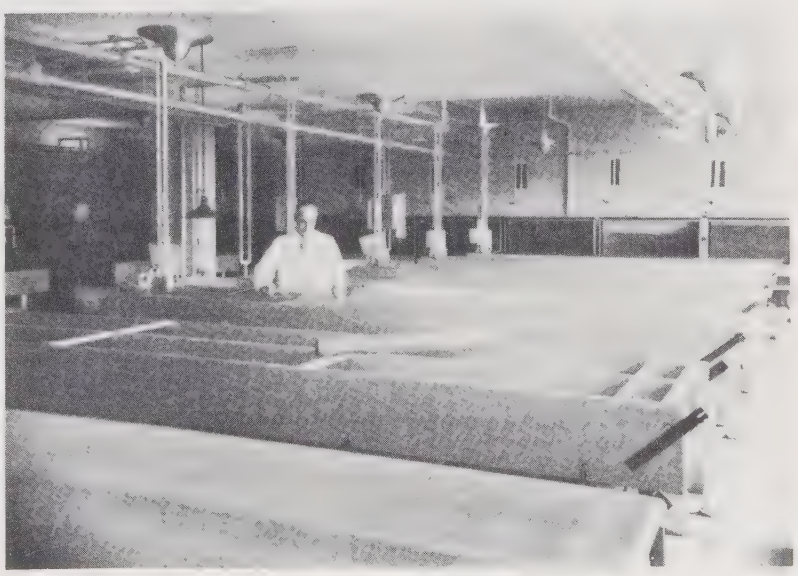
ROLL-AWAY SCREENS ON HATCHERY TROUGHS

PLASTIC SCREENS on rollers are more convenient than the standard framed screens on hatchery troughs used by the Western Fish Nutrition Investigation of the Fish and Wildlife Service at Seattle, Washington. J. E. Halver, head of this work, reports that the new screens offer many advantages.

The plastic screens, which are available in various widths, are wound on heavy-duty window-shade rollers and mounted on the hatchery troughs (see photograph). Rollers are available with capacities ranging from 6 to 40 feet.

When it is desired to uncover part of a trough, the screen is simply rolled back for a convenient distance.

The entire screen is easily removed for cleaning or for storage. When rolled, as shown on the second trough in the photograph, the screen takes little room for storage.



COMPARISON OF THE GROWTH RATES OF CHINOOK SALMON FINGERLINGS REARED IN CIRCULAR TANKS AND FOSTER-LUCAS PONDS

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TO COMPARE THE GROWTH RATES of chinook salmon fingerlings (Oncorhynchus tschawytscha) reared in Foster-Lucas ponds 76 feet long and circular tanks 3, 4, and 5 feet in diameter, two experiments were conducted at the Entiat Salmon-Cultural Laboratory of the Fish and Wildlife Service during the summer and fall of 1951.

Some fish tend to grow more rapidly in certain types of rearing facilities than in others. This phenomenon frequently causes a problem in hatchery management, particularly when uniform growth of fish in two or more designs of rearing tanks is desired. For example, to determine the amount of food to feed fish in ponds, "pilot troughs" are often used. In this procedure, a small representative sample of the fish from each pond is reared in the hatchery and weighed periodically, and the gains are used to estimate the weight of the fish in the pond. This estimated weight is then used to calculate the amount of food to be fed. Johnson and Gastineau (1952) compared the growth of fall chinook salmon fingerlings reared in standard deep hatchery troughs, 6-foot circular tanks, and 140-foot raceways. They demonstrated that the fish grew at a uniform rate until they attained an average weight of approximately 8 grams. Beyond this point, the growth of the fish in the circular tanks and large raceways continued at the uniform rate, whereas that of the fish in troughs was greatly reduced.

In practical fish-cultural research, the results of studies which are conducted with small lots of fish must be directly applicable to large-scale production. There is, therefore, a need for small experimental tanks which are compact yet capable of producing growth comparable to that of large production tanks or ponds.

These experiments at the Entiat Salmon-Cultural Laboratory were designed not only to compare the growth rate of fish in small circular tanks with the growth rate of fish in Foster-Lucas ponds, but also to compare the growth of fish in three different sizes of circular tanks in an effort to determine the effect of reduced areas on growth.

Methods

Each of the four Foster-Lucas ponds used in these studies measured 76 feet in length and had a capacity of 3,779 cubic feet of water. The inflowing water, directed horizontally, produced currents of 0.8 feet per second at the outside edges of the ponds.

The circular tanks tested consisted of three groups of four tanks each. The diameters of the tanks in the first group measured 3 feet; those of the second group, 4 feet; and those of the last group, 5 feet. The capacities (in cubic feet) for the three sizes of the tanks were 7.07 per 3-foot tank, 12.57 per 4-foot tank, and 19.64 per 5-foot tank. All circular tanks were of wooden construction and had flat bottoms, center screens, and center drains.

The first experiment, which began on July 9 and extended to August 22, was designed to compare the growth rates of fish in the three sizes of circular tanks. A stocking ratio of 0.177 pound of fish per cubic foot of water was used in this experiment. This ratio, based on previous experience with 6-foot circular tanks, was purposely set low in order to guarantee the exclusion of another variable, that of a reduction in growth due to overstocking. The 2,192 fingerlings for the experiment, which averaged 79 per pound, were selected from a large group of uniform fish. The fish were divided by means of the sampler described by Hewitt and Burrows (1948). The stocking of the tanks was as follows: 1.25 pounds or 568 grams of fish per 3-foot tank, 2.22 pounds or 1,008 grams of fish per 4-foot tank, and 3.47 pounds or 1,575 grams of fish per 5-foot tank. The average number of fish per tank was 99 for the 3-foot tanks, 175

for the 4-foot tanks, and 274 for the 5-foot tanks.

The mean water temperature during this period was 56.1° F., the average biweekly temperatures rising gradually from 54.6° at the beginning of the experiment to 57.1° at the end.

The fish in all these tanks were fed the same diet at all times. A feeding chart for chinook salmon, based on fish size, total weight, and water temperature, was used to determine the amount of food fed. All the fish were weighed at biweekly intervals to measure the gains in weight, and the amount of food was increased accordingly. The food was distributed by means of a standard hand ricer.

The second experiment, which began on August 23 and extended to October 2, was designed to compare the growth rates of fish in the three sizes of circular tanks and the Foster-Lucas ponds. Aside from a few slight changes, the methods used in this experiment were similar to those used in the first experiment. The stocking ratio used in the circular tanks was set at 0.28 pound of fish per cubic foot of water, a ratio comparable to that of the first experiment at the time of its termination. With a surplus of ponds available for use, the ratio of fish per cubic foot of water for the Foster-Lucas ponds was considerably less than that of the circular tanks. The ratio for the ponds was 0.145 pound of fish per cubic foot of water. The 105,105 fingerlings used for the experiment averaged 48 per pound. A representative sample of 2,128 fish was selected from the group and divided by means of the sampler used in the first experiment, and the sample fish were stocked into the 12 circular tanks. Stocking of the circular tanks was as follows: 1.98 pounds or 900 grams of fish per 3-foot tank, 3.52 pounds or 1,598 grams of fish per 4-foot tank, and 5.50 pounds or 2,498 grams of fish per 5-foot tank. The average number of fish per tank was 96 for the 3-foot tanks, 170 for the 4-foot tanks, and 266 for the 5-foot tanks. Each Foster-Lucas pond was stocked with 547.5 pounds of fish, an average of 25,744 fish per pond.

The mean water temperature during this second experiment was 55° F., the average biweekly temperatures rising from 55.8° at the beginning to 55.9° at the halfway point and then falling to 53.2° at the end.

TABLE 1.--First experiment: chinook salmon fingerlings in 3-, 4-, and 5-foot circular tanks for period beginning July 9 and ending August 22

	Circular tanks		
	3-foot	4-foot	5-foot
Cubic foot capacity per tank	7.07	12.57	19.64
Average number of fish per tank	99	175	274
Average weight per fish at start, in grams	5.75	5.75	5.75
Number of fish per pound at start	79	79	79
Average weight per fish at end, in grams[1/]	9.92	9.24	9.78
Number of fish per pound at end	46	49	47

[1/] Least difference for significance between final mean weights at 5-percent level, 1.39 grams; at 1-percent level, 2.11 grams.

All fish received the same diet at all times. The fish in the circular tanks were weighed at biweekly intervals to measure the gains in weight, and the amounts of food were increased accordingly. The gains made by the fish in all the circular tanks, as a whole, were used to estimate the weights and calculate the food increases for the fish in the Foster-Lucas ponds. A standard hand ricer was used to feed the fish in the circular tanks; a large pond ricer was used for the ponds.

Experimental Results

The results of the first experiment are shown in table 1. The gains made by the fish in all the tanks varied only slightly and appeared to be well within the bounds of normal biological variation. Analysis of variance (Snedecor 1946) of the average weight of individual fish per tank confirmed this observation. The analysis revealed that no

TABLE 2.--Second experiment: chinook salmon fingerlings in Foster-Lucas ponds and 3-, 4-, and 5-foot circular tanks for period beginning August 22 and ending October 2

	Circular tanks			Foster-Lucas ponds
	3-foot	4-foot	5-foot	
Cubic foot capacity per tank	7.07	12.57	19.64	3,779.00
Average number of fish per tank	96	170	266	25,744
Average weight per fish at start, in grams	9.37	9.37	9.37	9.37
Number of fish per pound at start	48	48	48	48
Average weight per fish at end, in grams[1/]	11.64	11.77	11.53	11.52
Number of fish per pound at end	39	39	39	39

[1/] Least difference for significance between final mean weights at 5-percent level, 1.40 grams; at 1-percent level, 2.13 grams.

differences existed between the fish reared in the 3-, 4-, or 5-foot circular tanks.

The results of the second experiment, which appear in table 2, were a confirmation of the results of the first experiment. The weight increases of the fish in all the tanks and ponds were extremely uniform. Analysis of variance of the average weight of individual fish for each tank and pond showed that there was no difference between the fish reared in Foster-Lucas ponds and in 3-, 4-, or 5-foot circular tanks.

Conclusions

Under the conditions of these experiments, the following conclusions can be drawn:

1. Salmon fingerlings reared in Foster-Lucas ponds and in circular tanks having 3-, 4-, and 5-foot diameters grow at the same rate.

2. Circular tanks of 3-, 4-, or 5-foot diameters are satisfactory for use in the rearing of a small representative sample of the fish from a Foster-Lucas pond, this sample to serve as a means of measuring the growth of the fish in the pond.

3. For use in the experimental hatchery, circular tanks as small as 3 feet in diameter produce growth comparable to that of Foster-Lucas ponds.

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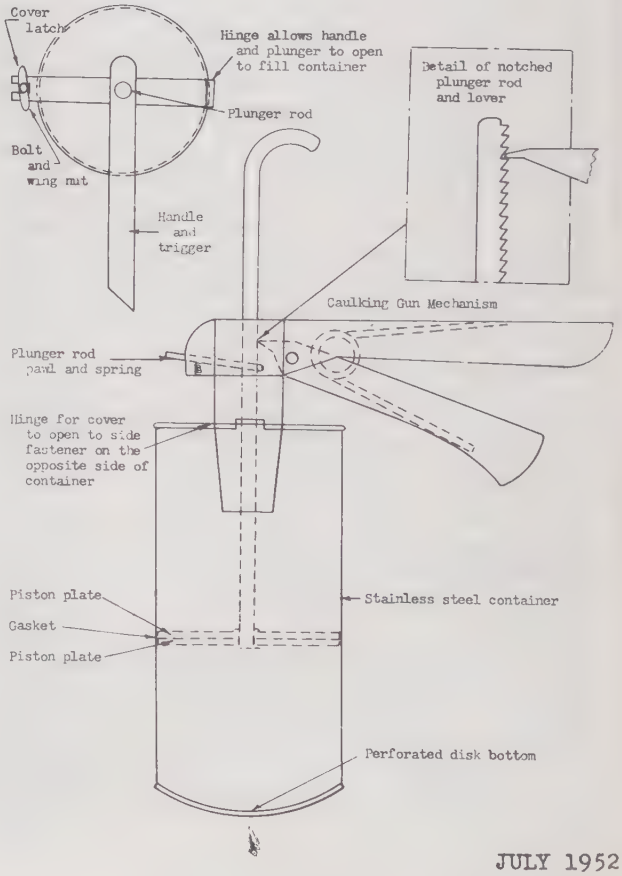
TROUT FEED DISPENSER

A MODIFICATION of the potato ricer for use in feeding trout has been submitted by Raymond L. Wilmot of the U. S. Fish-Cultural Station at Lake Mills, Wisconsin.

The two long arms of the ricer have been replaced by a mechanism taken from a window-caulking gun (see drawing). With a ricer operated by the two-arm squeeze action, the angle of movement of the piston limited the size of container that could be used. The new set-up, however, makes it possible to push the feed through the holes in the bottom of a container of any length or depth. Under the present arrangement, the length or depth of the container is determined by the length of the notched rod that is attached to the feeder piston, and the finger trigger (which has immense leverage and is very easy to operate) actuates a direct downward push. The entire mechanism can be moved out of the way by hinge action when the container is to be refilled.

Though a gallon container could be used as the feed reservoir, the preference at the Lake Mills Station is for a container of less capacity in order that the feeding unit may be held with one hand.


Cover latch
Hinge allows handle and plunger to open to fill container
Detail of notched plunger rod and lever
Plunger rod
Bolt and wing nut
Handle and trigger
Caulking Gun Mechanism
Plunger rod pawl and spring
Hinge for cover to open to side fastener on the opposite side of container
Piston plate
Gasket
Piston plate
Stainless steel container
Perforated disk bottom

INKS FOR MARKING PLASTIC FISH TAGS

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THE AUTHOR was planning a trout-tagging program in the winter of 1949-50 and he had available for the work a supply of bright red and bright yellow Peterson disk tags made of cellulose acetate. These tags bore no printed marks; this was a disadvantage for the purposes of the tagging study contemplated. A method of quickly numbering 6,000 of the red and yellow disks was required, and it was obvious that marking by metal dies would not be sufficiently economical to justify the operation. It was decided to explore the possibility of using inks that could be applied to the fish tags with an ordinary steel pen or a brush.

Materials

A white ink and a dark ink were needed for the red tags, and red and green inks were desired for marking the yellow tags. The white ink used is made by The California Ink Company, Inc., of San Francisco, California, and is known as Cellulose Acetate Steel Pen White, 104W5-1. Red ink was prepared according to the following formula:

acetone	10 cc.
glacial acetic acid ...	0.50 cc.
dissolved cellulose acetate	525 mg.
Basic Fuchsin (Magenta; Aniline Red) dye	35 mg.

The cellulose acetate was dissolved in the acetone, and the acetic acid and dye were then added. The cellulose acetate, in the form of three red Peterson disks, was used to increase the viscosity of the ink so it would not flow from the pen too freely. Dark-blue ink was prepared according to the same formula except that 0.50 cubic centimeter of Delafield Hematoxylin solution was used in place of the red dye. Green ink was prepared with 35 milligrams of Malachite Green dye as the coloring agent. Both steel pens and small camel's-hair brushes were satisfactory for lettering and numbering the tags. For this operation, steel pens were used.

Aquarium Tests

Through the kindness of Dr. Earl S. Herald of the Steinhart Aquarium in San Francisco, California, red disks with white numbers and yellow disks with red numbers were placed on fish held in tanks in that aquarium in February 1950. Red disks and yellow disks were put on striped bass (Roccus saxatilis) in salt water and on coastal cutthroat trout (Salmo clarkii clarkii) in fresh water. The tags were examined periodically for signs of fading, scratching, and mechanical wear; and after 3 months it was concluded that all the numbers had remained sufficiently clear to warrant the use of the method in larger field tagging programs. Accordingly, tags were marked by this method for use on Yellowstone Lake in Wyoming in the summer of 1950.

In the meantime, a set of marked tags was left on a trout in Steinhart Aquarium to test effects over a longer period of time. In April 1951, after exposure for 14 months in fresh water, the tags were taken from the trout. The numbers were clearly legible, impaired only a trifle by numerous scratches on the tag surface. The white ink, which dries to produce a ridge on the tag surface, was more affected by scratching than was the red ink, which, on drying, penetrates the substance of the tag.

Field Use

Peterson disks marked by this method and used in tagging operations with Yellowstone cutthroat trout (Salmo clarkii lewisi) on tributaries of Yellowstone Lake in the summer of 1950 underwent some changes immediately after the tagging was begun. The first tags used, yellow tags with red numbers, exhibited a slight bleaching of the ink upon exposure to bright sunlight. This fading was not serious

at first; the numbers were not obscured to the point of illegibility. The effects of water on the numbers apparently were insignificant. Only after several hundred fish had gone upstream to spawn, had been checked back downstream into Yellowstone Lake, and were being recovered in the fishery--only after this were some of the numbers so faded that they could not be recognized. In the 1950 program, 1,879 fish were tagged with yellow tags bearing red numbers. Of the 205 recovered in the fishery, 11 (5.67 percent) could not be read. In 1951, 7 of these tags were recovered in the fishery, and 2 (28.6 percent) were unrecognizable. In 1950 and 1951, 15 of these tags were found on Molly Island in Yellowstone Lake, in or near the nests of white pelicans. Most of these tags had passed through the digestive tracts of birds, but only 4 tags could not be read.

A series of 1,500 red tags marked with white numbers was placed on cutthroat trout in Chipmunk Creek on the South Arm of Yellowstone Lake during the summer of 1950. Though recoveries from this series--recoveries in the fishery, from Molly Island rookeries, and in later spawning runs--were small in number, amounting to 43 in 1950 and 18 in 1951, all the recoveries were plainly readable. The effects of wear and scratching observed in the earlier aquarium tests were not so pronounced in Yellowstone Lake, despite the fact that the trout had gone through spawning activities and had been exposed to a variety of environmental situations. Some fish recovered in 1951 had borne readable tags even longer than the fish that carried tags for 14 months in the aquarium.

Dark-blue ink was used to mark a series of 965 red tags on cutthroat trout in Arnica Creek at Yellowstone in 1950. Recoveries in the fishery and from the pelican rookery on Molly Island during 1950 amounted to 69 fish, and the tag markings on 14 fish (25.45 percent) were not legible; recoveries from the same sources during 1951 amounted to 60, and 37 (61.7 percent) of the tag markings could not be deciphered. The principal damage here, as with the red ink on yellow tags, appeared to be due to the action of sunlight rather than to mechanical causes.

A series of green tags was made by dipping yellow tags into green ink prepared according to the formula given. The green disks were put on 500 trout in Pelican Creek in Yellowstone in 1950, and bleaching was noted shortly after exposure to sunlight. From the fishery and from Molly Island, 10 of these tags were recovered in 1950, and 1 in 1951. In all cases, the green dye had practically disappeared from the outer faces of the tags, and recognition was certain only by reference to the inner surfaces that lay in contact with the fish. Some protection from sunlight had apparently been afforded through this contact, and some of the green dye had been retained.

Other Plastics

Peterson disks and other fish tags are often made of plastics other than cellulose acetate. Some workers prefer to use cellulose nitrate tags, especially for marine fish; other workers use vinylite tags. The inks described here have not been tested on cellulose nitrate or vinylite tags in field use, but the Steel Pen Cellulose Acetate White, when applied to vinylite in the laboratory, makes a mark which apparently is durable with respect to scratching and wear.

Commercial inks of apparently good durability and in a variety of colors are now available for fish tags made of cellulose nitrate and vinylite.

Summary

For an extensive trout-tagging program on Yellowstone Lake in 1950, the use of permanent inks on red and yellow cellulose acetate Peterson disks was explored. A white commercial ink on red tags and a red ink developed in the laboratory for yellow tags were tested on cutthroat trout in fresh water and on striped bass in salt water in the Steinhart Aquarium in San Francisco. After 3 months in the aquarium, the inks were still clearly legible; so it was decided to make use of these materials in the field tagging program at Yellowstone.

The series having white numbers on red tags showed excellent lasting qualities, as the 61 recoveries were clearly readable at the end of the 1951 season. The series bearing red ink on yellow tags showed some bleaching, an effect of sunlight on the red ink, but 199 of the 212 returns from this series were readable. A series featuring blue ink markings on red tags was less satisfactory, for only 78 numbers among 129 recoveries could be read by the end of the second season. Least satisfactory was a green ink on yellow tags, practically all of which faded to some extent soon after exposure to bright sunlight.

PSEUDOMONAS HYDROPHILA, THE CAUSE OF "RED MOUTH" DISEASE IN RAINBOW TROUT

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A SEVERE BACTERIAL DISEASE involving large numbers of rainbow trout (Salmo gairdnerii) has occurred on numerous occasions in various trout hatcheries in California. This disease has been referred to as "red mouth" by some writers because of an inflammation occurring in the mouth. Other parts of the fish, however, are also involved.

That Pseudomonas hydrophila is the cause of "red leg" disease in frogs has been shown by several studies, among which may be listed those of Emerson and Norris (1905), and Kulp and Borden (1942). Reed and Toner (1942) described "red sore" disease in pike, "ulcer" disease in brook trout, and "red leg" disease in frogs in Ontario. Margolis (1951) found "red sore" in pike in Quebec. The causative organism isolated from the infected animals was reported to be Ps. hydrophila.

The symptoms reported by Seaman (1951) in his description of a bacterial disease in rainbow trout in a Colorado hatchery appear to be similar to, if not identical with, the symptoms in "red mouth" disease observed over a period of several years in the hatcheries where the present studies were conducted. A bacterium of the genus Pseudomonas, species undetermined, was isolated by Seaman from the diseased fish.

An unpublished report on investigations made in 1948 in a southern California hatchery shows the recovery of Ps. hydrophila from rainbow trout with symptoms of "red mouth."

The purpose of this study was to determine, if possible, the causative agent of this disease, the various factors associated with its epidemiology, and the treatment.

Symptoms

Diseased trout become sluggish, show inadvertent behavior, and frequently become dark in color because of pigment production. The oral cavity exhibits a pink or reddish inflammation. Similar inflamed conditions occur at the base of the fins and the distal portion of the intestine, the contents of which become a yellow liquid. Frequently there is involvement with erosion of the anal orifice. The spleen and kidney may become almost black, the liver is often pale, and the bile is yellow. In the terminal stages, the fish execute swift corkscrew motions, sink, and frequently float "belly up" until dead.

Methods and Results

Isolation of bacteria from diseased fish was made in the following manner: The fish in the terminal stages of the disease were placed in 70 percent alcohol for approximately 15 minutes. The fish were then removed and the alcohol on them was ignited. The flame was extinguished after about 1 minute. When a ventral incision had been made, isolations were taken by loop or forceps from the heart and kidney, and occasionally from the spleen, intestine, gall bladder, and liver.

Fish peptone agar as described by Snieszko, Griffin, and Friddle (1950) was used in making the original isolations from the fish. This medium gave the best growth, although satisfactory results were obtained on blood agar, nutrient agar, and tryptose-glucose agar plates, as well as in brain heart infusion broth. Best growth was obtained at temperatures ranging from 15° to 30° C. Colonies grown on nutrient agar became evident after 12 hours of incubation at 30° C. These colonies were convex, entire, smooth, shiny, and milk-white in color. The bacteria from these colonies were motile and, when stained by Gram's method, appeared as Gram-negative rods occurring singly or in pairs and measuring 1.5 to 2.5 microns long. Pleomorphic forms were frequently present.

There were some variations in the biochemical tests; however, these were in agreement with variations ascribed to Ps. hydrophila by other investigators, as Emerson and Norris

(1905), Kulp and Borden (1942), and Reed and Toner (1942). Acid and gas were produced from dextrose, sucrose, maltose, mannitol, sorbitol, and levulose; galactose was variable. The production of acid was recorded for inositol. A weak acid reaction was observed on lactose. Indole was formed, while the production of hydrogen sulfide was variable in Kligler's iron agar. The methyl-red reaction was negative; the Voges-Proskauer, positive. Nitrites were produced from nitrates, and variable results were obtained on citrates and litmus milk. Gelatin was liquefied, starch was hydrolyzed, and urea was not attacked.

Ps. hydrophila, strain 491 (secured from the National Research Council, Ottawa, Canada) and strain 9071 (from the American Type Culture Collection, Washington, D. C.) gave biochemical reactions similar to those recorded for our strains. When injected (0.1 cc., intramuscularly) into frogs, both strain 491 and our strain 19 produced "red leg" with 58 percent (7/12) fatalities. The organism was reisolated from the diseased frogs. White mice that received 0.5-cc. intraperitoneal injections of these same strains succumbed within 18 hours to 4 days, whereas white mice that received 0.25-cc. injections survived.

Discussion

Reed and Toner's suggestion (1942) that frogs act as carriers of Ps. hydrophila, seems logical. Kulp and Borden's experiments (1942) show that the portal of entry of this organism is the abraded skin, not the mouth. In our own experience it was observed that wherever an epidemic of "red mouth" occurred, the presence of Gyrodactylus, an external monogenetic trematode, was noted. As these ectoparasites are capable of causing skin abrasions with their haptoral hooks, they may be an important agent in the transmission of this disease.

It was observed that epidemics occurred only during the summer when the water temperature rose to about 21° C. Only a few isolated cases were found during the winter.

Treatment was satisfactory with some of the sulfa drugs, notably sulfathia-zine (a combination of sulfathiazole and sulfamethazine of veterinary grade from Southwest Laboratories, San Diego, California). In vitro tests with terramycin on our strain 19 of Ps. hydrophila showed significant bactericidal (0.078 mcg./ml.) and bacteriostatic (10 mcg./ml.) effects. Preliminary results from some antibiotics in one hatchery indicate that they are as effective as the sulfa drugs, without the toxic effects produced by the latter.

It is interesting to note that Ps. hydrophila produces ulcers in pike and brook trout, but not in rainbow trout. Whether this is due to differences in strains of the organism or of the species of animals infected, is unknown.

Summary

Pseudomonas hydrophila is shown to be the causal agent of "red mouth" disease in rainbow trout. Correlation is made between the diseases produced by this bacterium in frogs, pike, brook trout, and rainbow trout. The organism and the method used in its isolation are described. Also, the possible etiology and treatment of "red mouth" are discussed.

Acknowledgments

The authors are indebted to the California Trout Company, Mentone, California, for financial assistance, equipment, and supplies used in this study. They wish to express gratitude to Mr. Edward N. Azarowicz, recently with the School of Tropical and Preventive Medicine, for assistance. The in vitro tests with terramycin conducted by Chas. Pfizer and Company are gratefully acknowledged.

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THE PROPAGATION OF BUFFALO

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U. S. Fish and Wildlife Service
Natchitoches, Louisiana

BIGMOUTH BUFFALO, Megastomatobus cyprinella (Valenciennes), and smallmouth buffalo, Ictiobus bubalus (Rafinesque), were propagated in 1951 at the U. S. Fish-Cultural Station at Natchitoches, Louisiana. The purpose was to secure fish of fingerling size for use in experiments. As there are no recent reports of buffalo propagation in the literature, it has seemed advisable to report these two experiments.

Artificial Propagation

In this experiment both bigmouth and smallmouth buffalo were artificially propagated in hatching jars. Preparation for the jar-hatching of buffalo eggs consisted of securing two hatching jars and constructing a small wooden reservoir (30 inches by 6 inches by 6 inches) with two barrel faucets to control the flow of water to the jars. This reservoir was placed under the overflow of a large holding tank, and the water in the tank was regulated so that the reservoir remained full while the jars were in operation. In order to keep the eggs circulating freely, a metal tube was placed in the center of each jar to force the water (coming into the jar from a rubber tube) up from the bottom.

On March 29, 1951, 2 days after a heavy rain, workers at the station were notified that buffalo were spawning in the hoop nets of a local commercial fisherman. The junior author, a fish-culturist at this station, went to the site of the fishing operations and selected brood fish as the fisherman unloaded fish that had been taken in hoop nets from his boat. The fish were easily sexed, as at spawning time the female buffalo is smooth while the male is covered with small rough protuberances that give a "sandpaper" effect.

Immediately after their removal from the hoop nets, three smallmouth buffalo weighing about 8 pounds and two bigmouth buffalo weighing about 4 pounds were artificially spawned by the following method:

Approximately 1 pint of water was placed in a washbasin. A ripe male was selected, and the milt was expressed into the basin by firmly pressing the abdomen of the fish between the thumb and forefinger of one hand. The pressure was begun near the ventral fins and continued to the vent. About 1 teaspoonful of milt was used for each pint of eggs. Immediately after the milt had been secured, a female with eggs already exuding was selected and stripped into the basin in the same manner as the male fish. (Ripe eggs are watery and free flowing.) The eggs were stirred gently with a feather for about 5 seconds. Then most of the water and milt was poured off and approximately 2 ounces of corn starch and another pint of water were added to the contents of the basin. The addition of corn starch was for the purpose of keeping the eggs (which are highly adhesive at this stage) from adhering in a mass. The eggs were stirred with a feather for 1 hour. (When they were stirred only 30 minutes, the eggs adhered badly. This resulted in some loss in smallmouth buffalo eggs.) During the latter half of this period the water was poured off and fresh water added several times. After an hour's stirring, the eggs had water-hardened and did not adhere when allowed to set for a short time. The water-hardened eggs were approximately twice the size of the freshly stripped eggs. The eggs were then placed in a Fearnow pail and brought to the hatchery, where they were put in the hatching jars. It should be mentioned here that care was taken to use fish of the same species in the fertilization procedure and to keep them separate in the hatching jars.

The eggs were kept "boiling" gently for 10 days. Spot checks of the water temperature

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Since the preparation of this paper, Mr. Frank has resigned from the Fish and Wildlife Service. He is now working for a bachelor of science degree in fish culture at Alabama Polytechnic Institute, Auburn, Alabama.--The EDITORS.

during the incubation period revealed the following data: March 30, 57° F.; April 2, 58° F.; April 3, 61° F.; and April 6, 62° F. On April 7, many eggs were seen to be infested with fungus and were removed by siphoning. One ounce of a saturated solution of copper sulphate (Cu SO4) was placed in the reservoir and allowed to circulate through the eggs. It was believed that this treatment was of some benefit in retarding the growth of fungus. The eggs began to hatch on the morning of April 9, when the water temperature was still 62° F. They hatched slowly for 2 days.

The fry swam over the lip of the jars into a tank of water. The fry were left in this tank for 2 days so that they might absorb most of their egg sacs and become stronger. At first, the fry were about the size of mosquito larvae and transparent.

On April 13, the fry were transferred to a small (0.28-acre) rearing pond. Cottonseed meal was supplied several times in 10-pound applications. Because of the large number of fish in the small rearing pond (approximately 200,000 hatched), growth was not so rapid as had been hoped. For this reason, 2,000 fish were seined out and placed in another pond (0.88-acre) on May 7. On May 21, these fish were checked for size and found to be 2 inches in length. On June 4, the pond was drained and the fish were separated into the two species present. At this time the fish were 3 inches long and weighed 10 pounds per thousand.

Natural Propagation

In the second experiment smallmouth buffalo spawned successfully in a pond in which the water level was raised slowly. This method of propagation was first described by Canfield (1922).

A shallow pond with an area of 1.3 acres was partly filled with water on February 18. The pond was stocked on February 21 with seven male and five female smallmouth buffalo that had an average weight of 5 pounds. These brood fish had been obtained from a local commercial fisherman and were in good condition. The water temperatures at the time of stocking ranged from 56° to 60° F.

The fish were given 3 days to adjust themselves to the pond. After this adjustment period, the water level in the pond was raised 2 feet during 1 week by the addition of fresh water. This was done to create conditions similar to those occurring with the natural rise of the river in the spring, a situation which usually causes buffalo to spawn. Hay was scattered throughout the pond to furnish spawning material.

The ponds were checked daily for evidence of spawning activity. No activity was noted in 1 month, but during this period the water temperature dropped to 41° F. On March 27, a heavy rain fell, causing the water level of the pond to rise a foot or more. The following day the buffalo showed signs of activity and the pond appeared muddy in several places. The water temperature at this time was 62° F. Two weeks later, tiny buffalo were seen in partial schools at the margin of the pond.

On June 4, the pond was drained and 15,000 No. 3 buffalo fingerlings, weighing 112.5 pounds, were recovered.

It should be noted that ripe eggs were taken artificially in the river the day after spawning was observed in the pond. Young buffalo in schools were observed in the pond just after they finished hatching in the jars.

Literature Cited

Canfield, H. L.
1922. Care and feeding of buffalo fish in ponds. U. S. Dept. Com. Econ. Circ. 56, 3 pp.

That salmon fishermen should handle baits and lures with gloves is the suggestion of J. R. Brett and D. MacKinnon in the March 1952 Progress Report of the Pacific Coast Stations.

At a counting point on a fish ladder on the Stamp River, Vancouver Island, in the fall of 1951, the immersion of an observer's hand for 1 minute was followed by a sudden and striking reduction in the rate of upstream migration of sockeye, coho, and spring king salmon. From a mean rate of 34 coho per 10 minutes, the number dropped to 4, and another test an hour later resulted in a similar decrease.

Subsequently, on the Stamp and Cowichan Rivers, tests with hand rinses and solutions of various kinds introduced in waxed cardboard containers indicated that only the hand rinses were repellent to the salmon. In three instances, salmon returned to a lower level when hand rinses were introduced.

OPERATION MACKINAW

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NATURAL REPRODUCTION in some Wyoming waters does not provide an adequate population of game fish. It is necessary, therefore, to stock fish in locations where good spawning conditions are lacking or where "put and take" fishing occurs. The Department's policy has been to get eggs from stocks of wild or hatchery brood fish in Wyoming whenever possible.

The lake trout (Cristivomer namaycush) is not a native of Wyoming but has been planted to a number of lakes and reservoirs. Because the species is of great interest to anglers, the Department tries to maintain stocks where the fish may be expected to thrive.

"Operation Mackinaw" was conducted by the Fish Division in the fall of 1951 to get lake trout eggs at Dome Lake, a 150-acre lake at about 8,200 feet in the Big Horn Mountains.

Three hauls with a 250-foot sack seine on September 17 took only one immature female, as vegetation and boulders made seining difficult.

A box trap with two 25-foot wings and a 100-foot lead took no fish from October 11 to October 22, perhaps because of incorrect location or insufficient length of wings and lead.

As further attempts to seine failed and trolling gear was ineffective, gill nets were tried. Gill nets with a mesh spread of about 1 inch have been reported most satisfactory, but nets with various sizes of mesh were tried at Dome Lake to determine the most effective.

On October 19, two 200-foot experimental gill nets with a graduated mesh (3/4 to 2-5/16 inches, bar measure) and one 100-foot net of 1-inch mesh were set. One end was anchored in about 10 feet of water near shore; the remainder was released from the stern as the boat moved over the lake. Usually the offshore end was anchored in about 30 feet of water; occasionally it was allowed to float free.

Three inspections were made on October 20. At the first, 12 mature males and 1 mature female were found: 1 adult and 1 immature in the 1-inch net, the rest in the experimental nets. At the second, the experimental nets held 2 mature females. At the third, the experimental nets held 3 immature trout.

Next morning, the 1-inch net had 1 mature female and the experimental nets had 1 mature female, 3 mature males, and 9 immature trout.

Bad weather delayed further inspection till the morning of October 22, when the experimental nets had 1 adult male and 4 immature fish.

Netting of 1½-inch bar measure apparently took most fish. Most of the large fish did not gill themselves but were trapped when the teeth and mouth bones became entangled in the nets. The large mesh of the experimental nets took no fish. The largest fish taken was a buck measuring 40¼ inches in total length and weighing 25 pounds 4 ounces.

Fish taken from the nets were put in burlap bags and dangled in the water till the live car was reached. Other workers have reported that netted lake trout die quickly, but Dome Lake trout that had been in nets twenty-odd hours were in very good condition. Only one, an immature fish, died during this operation.

Spawntaking was begun about 11 a.m. on October 22, when the air temperature was 24° and the surface water temperature was 33° F.

Only 5 of the 37 fish taken were mature females. One of these, about 18 inches in total length, had already spawned. A second, about 20 inches in total length, produced many eggs, but only a few were good. The other three, whose total lengths ranged from 24 to 36 inches, produced about 12,000 eggs.

Because of the low temperatures, eggs were taken by the wet method. Milt was taken in a spawning pan that held about 1 inch of water, eggs were ejected, and more milt was added. After an hour's water-hardening, the eggs were put in quart fruit jars. When the lids had been screwed down under water, the jars were put in a wooden box and covered with sawdust.

At the State Fish Hatchery at Story, the eggs were tempered and put on trays about 7 p.m. on October 22. In the first 2 days of incubation, 200 infertile eggs were removed.

Faintly eyed on November 28, the eggs began hatching on January 8, 1952. By January 25, 7,068 had hatched. The average water temperature during the incubation period was 42° F.

REVIEW

ELEKTROMIKROSKOPISCHE UNTERSUCHUNGEN ÜBER DEN ERREGER DER INFEKTIÖSEN BAUCHWASSERSUCHT DER KARPFEN--BAKTERIUM ODER VIRUS?

By Sophie Roegner-Aust, Gertrud Brunner, and Ruth Jaxtheimer
Allgemeine Fischerei-Zeitung 75 (17): 420-422. 1950.

Schaeperclaus, the well-known German fish-pathologist, made a very thorough and basic study of the infectious dropsy (septicemia) of carp and other fresh-water fishes. He described Pseudomonas punctata as the bacterium causing this widespread disease. Ps. hydrophila, a bacterium very closely related to (if not identical with) Ps. punctata, has been described repeatedly as a fish pathogen on the North American continent.

In some of his experiments Schaeperclaus found that if a bacteria-free filtrate was prepared from the coelomic (abdominal) fluid of carp which contracted the dropsy (septicemia) in a natural way, the injection of such a filtrate in a normal carp would cause symptoms of the infectious dropsy that is attributed to infection with Ps. punctata. If, however, the filtrate was obtained from carp infected by inoculation with a pure culture of Ps. punctata, the filtrate proved not infectious. This indicated that the disease might be caused by a filterable agent (virus), and that Ps. punctata was a secondary invader.

Numerous observations also have shown that a fatal infection could be obtained only by massive injections with Ps. punctata. The infections were infrequent when normal carp were placed in water or fed food containing this bacterium. All these observations indicated that a virus might be the primary cause of the infectious dropsy of carp. Ps. punctata, a widely distributed water bacterium, may be responsible only for secondary symptoms like production of putrid furuncles, ulcerations, and a general bacteriemia.

Photomicrographs (made with an electron microscope) of the material removed from the coelomic fluid of carp suffering from a natural outbreak of dropsy (septicemia) revealed the presence of viruslike particles. Particles of the same type were also found in eyed eggs from infected carp. Such particles were not seen in the eggs of normal carp.

Observations reported by Roegner-Aust, Brunner, and Jaxtheimer--and by some Russian investigators, as quoted by these authors--seem to indicate that infectious dropsy of carp, and perhaps of other fishes, might be caused by a virus, while Ps. punctata (Ps. hydrophila) may cause additional pathological changes as a secondary invader. As fish mortalities apparently associated with infections caused by Ps. hydrophila are of increasing importance in the United States, this problem is important and deserves a thorough study.

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CLEARING HOUSE

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